HANDICRAFT IN THE SCHOOL

GENERAL ARRANGEMENT OF SUBJECTS

General Arrangement of Subjects

VOLUME III

School Drawing and Colour Work (Crayon, Brush, Pencil, and Charcoal). J. W. Topham Vinall, A.R.C.A.(Lond.).

Free-Arm Drawing—Natural and Common Objects—Graphic Expression and Figure Drawing—School-room Decoration—Painting

VOLUME IV

Educational Woodwork. A. W. Milton, Examiner in Manual Training, Education Department, Transvaal.

Principles and Practice—Class Management—Drawing Instruments and Their Use—Tools and Their Use—Practical Work, &c.

SUBJECT INDEX

HANDICRAFT IN THE SCHOOL

VOLUME II

HANDICRAFT IN THE SCHOOL

VOLUME II

Sand and Clay Modelling in Manual Training

F. W. FARRINGTON

WITH AN INTRODUCTION BY J. W. T. VINALL, A.R.C.A.

Bookbinding & Leaded Glass Work

LEWES R. CROSSKEY

Field Geography

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NOTE

The first section of this volume deals with the co-ordination of Sand and Clay Modelling, and the second part, which strictly succeeds the first, shows the correlation of Clay Modelling with Handicraft.

My grateful acknowledgment is due to Mr. J. W. T. Vinall, A.R.C.A., for his "Notes on General Principles", and also for his valuable assistance in the selection and arrangement of the plates, and his expert advice.

F. W. F.

CONTENTS

Sand and Clay Modelling

F. W. FARRINGTON

The aim of this section is to afford a stepping-stone to the more advanced lessons on "Clay Modelling" which follow. In the latter the exercises are largely of a disciplinary character; whereas these lessons are more elementary and are confined to illustrative methods bearing on the ordinary work of the classroom. No assumption is made to carry the pupil beyond the kindergarten stage; exactness and completeness are not expected, and crude effects are taken for granted.

The idea, somewhat prevalent of late, that the teacher is to efface herself or himself has no favour here. Demonstration and guidance will, of necessity, be required from time to time, but the more, within reason, the young pupils are left to work out their own ideas, the better.

Parts I and II (Plates I to VI) are intended to give a general survey of the relation between Sandwork and Clay or Plasticine Modelling, with indications of the co-ordination which may be established between them. They thus exemplify the sequence, the exercises common to both, and the points of divergence in these two kindergarten subjects.

Then follows in Part III (Plates VII and VIII) a suggested graduated course of exercises in plastic modelling, linked with the ordinary lessons of the week, and falling within the limits of the earlier pages.

Part IV comprises a few "Useful Hints" to teachers.

PART I

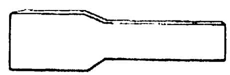
DRY SAND MODELLING

Scholars' Trays.—These are generally supplied 9 inches by 6 inches or thereabouts, and made of wood or tin. The latter kind are recommended, being cheaper, and unlike wood are not inclined to warp.

Teacher's Tray.—A diagram of this is shown on Plate IV. It measures 4 feet by 4 feet, and should be lined with zinc. Note that the back is raised. This will allow of extra relief and support at rear of tray.

Tools.—A wooden pointer as shown on Plate I might be used, although the tip of the forefinger generally suffices.

If wet or damp sand is used a sandcutter or patter will be required. (See illustration.)



Sand.—Finely granulated sand only should be used, and for the purpose of giving a more realistic effect silver and coloured sands should be available. For damp sand work there is nothing better than the common sea sand and green sand. A sugar sifter or pepper box could sometimes be used for scattering or putting on sand.

Effects.—Small shells and pebbles of pretty colours, also coloured marbles, beads, discs, and small sticks may be used for decorating or impressing the sand.

Toy railways, wagons, soldiers, villages, trees, &c., may also be effectively used in conjunction with sand modelling, more particularly if the modelling is done on a large scale and is co-operative.

(PLATE I)

Finger Exercises.—A pointed stick may be used or the tip of the forefinger (see *a*, Plate I):—

(*a*) Ship.

(*b*), (*c*) Letter and figure practice.

(*d*), (*i*), (*j*) Simple pattern making, lines, and spots, employing the "effects" mentioned above.

(*e*) Father's and mother's hats.

(*f*) Cricket.

(*g*) Two little boys, dog, house.

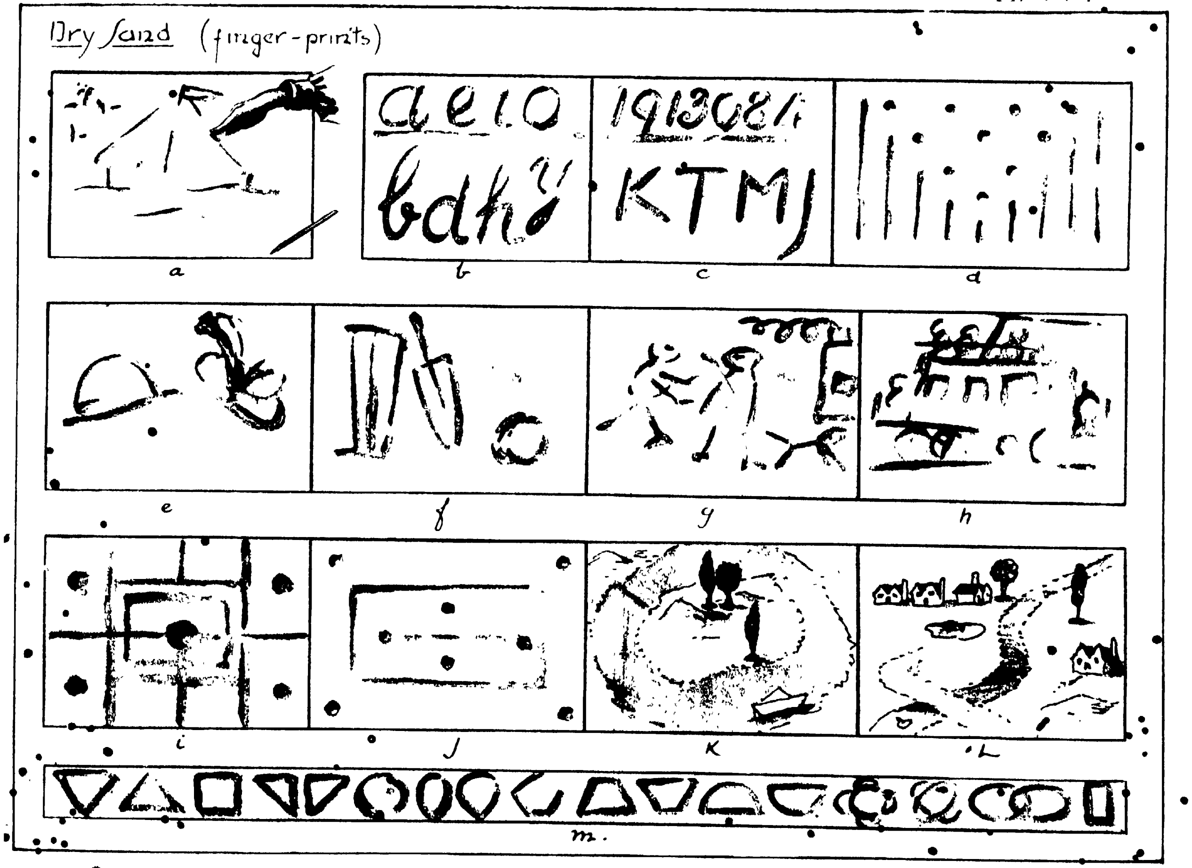
(*h*) Electric tram.

(*k*) Lake, island, paper boat, toy trees.

(*l*) Our village—cottages, lake, stream, bridge, trees.

(*m*) Simple figures. The teacher would draw these upon the blackboard and children copy. Garden beds might then assume some of these forms.

Each of the above is something more than a simple exercise, each is typical of the child's own expression, and has direct reference to the lesson of the day, for example *b* and *c* are associated with writing and number, the others with story-telling, &c.


Dry Sand (finger-prints)
a e i o
b d h y
1913084
K T M J
a
b
c
d
e
f
g
h
i
j
k
l
m.

(Plate II)

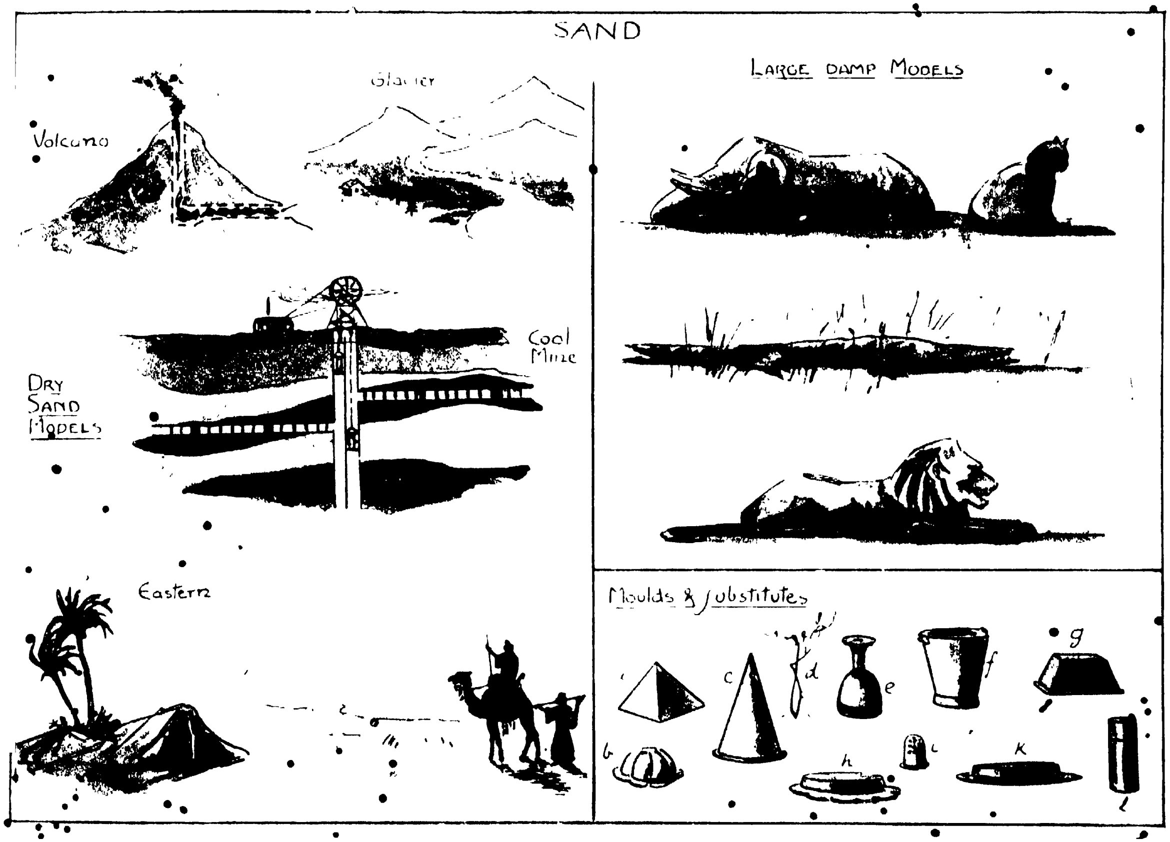
Co-operative Work.—This plate shows further examples of sandwork. The dry-sand "Geographical Models and Earth Strata Sections" would be mainly co-operative exercises with the teacher on the teacher's tray model. Cheap powdered pigments are added to the dry sand—white, blue, red, yellow, brown, green, &c., to give effect of snow, sea, land, verdure, &c. Soda or salt gives the effect of frost. Note "Contour Map", showing glacier with pigmented sands for valleys, &c.

The Volcano is piled around a piece of wood stood uprightly, and a hole is pierced through the side to reach the piece of wood. Remove pole leaving the chimney. If this be modelled on teacher's tray, insert some brown paper or old rags and set alight.

The Mine Section is best set up against an upright frame of glass, where the section is readily visible. Use differently coloured sand for strata, also actual soil, and for coal seam broken and powdered coal. A half-tube (curved cardboard) is placed against glass before starting to build section, to represent the shaft. Side passages project right and left, or diagrammatic flat strips of paper might be stuck on glass to serve the same purpose.

Wet Sand. Wet sand models of animals, crouching or sitting, are interesting, and if modelled on a large scale may be co-operative. Reeds and grasses may be added for jungle and forest effects.

Sand Moulds Simple Mechanical Processes.—Suitable sets may be purchased very cheaply, and if kept in reserve could be circulated around class in turns on different occasions. A few simple substitutes for sand moulds, however, are shown, and others will suggest themselves to the teacher. They would be mainly used in the co-operative models of villages, &c. (*a*) Pyramid for Egyptian scene; (*b*) jelly mould for domes or huts; (*c*) extinguisher for wigwam; (*d*) twisted hairpin to support leaves of model trees, placing clay around for the trunk; (*e*) inverted egg-cup for Eskimo huts and kraals; (*f*) child's bucket for forts; (*g*) toy bread-tin for bricks; (*h*) and (*k*) patty pans for small platforms or plinths; (*i*) thimble for chimney pots; (*l*) gas-mantle box for small towers, &c.


SAND
Volcano
Glacier
Large damp Models
Coal Mine
Dry Sand Models
Eastern
Moulds & Substitutes
c
d
e
f
g
b
h
i
k
l

SAND MODELLING

(PLATE III)

Sand Modelling in Playground.—The work may be done on a small scale individually on scholars' trays, or by teacher and scholars together either in the classroom, using teacher's tray, or in a reserved corner of the open playground boarded off.

The first drawing represents a miniature garden with small lake (sunk bucket of water or dish), using pebbles, broken shells, grasses, and small twigs to represent trees and bushes. Small celluloid animals could be added for effect.

The second shows the use made of moulded bricks.

The third is a hand-modelled castle and may be on quite a small scale.

The last represents a Helter Skelter with ball or marble to run down incline, or a Switchback Railway.

Quite ingeniously made animals can be modelled by children as is sometimes done at the seaside. Other subjects suggested are: Castle, farm, bridge, tunnel, viaduct, railway station, Tower of London, wagon, train and trucks, motor car or electric tram, man-of-war.

PLATE III

Moistened Sand (modelling)

PART II

CLAY OR PLASTICINE MODELLING

Material.—Clay is perhaps preferable as a plastic medium to any other substitute, but Plasticine in its various colours has unquestionably much to recommend it; and prepared coloured wax, known as "Permodelle", is useful, more especially for floral work.

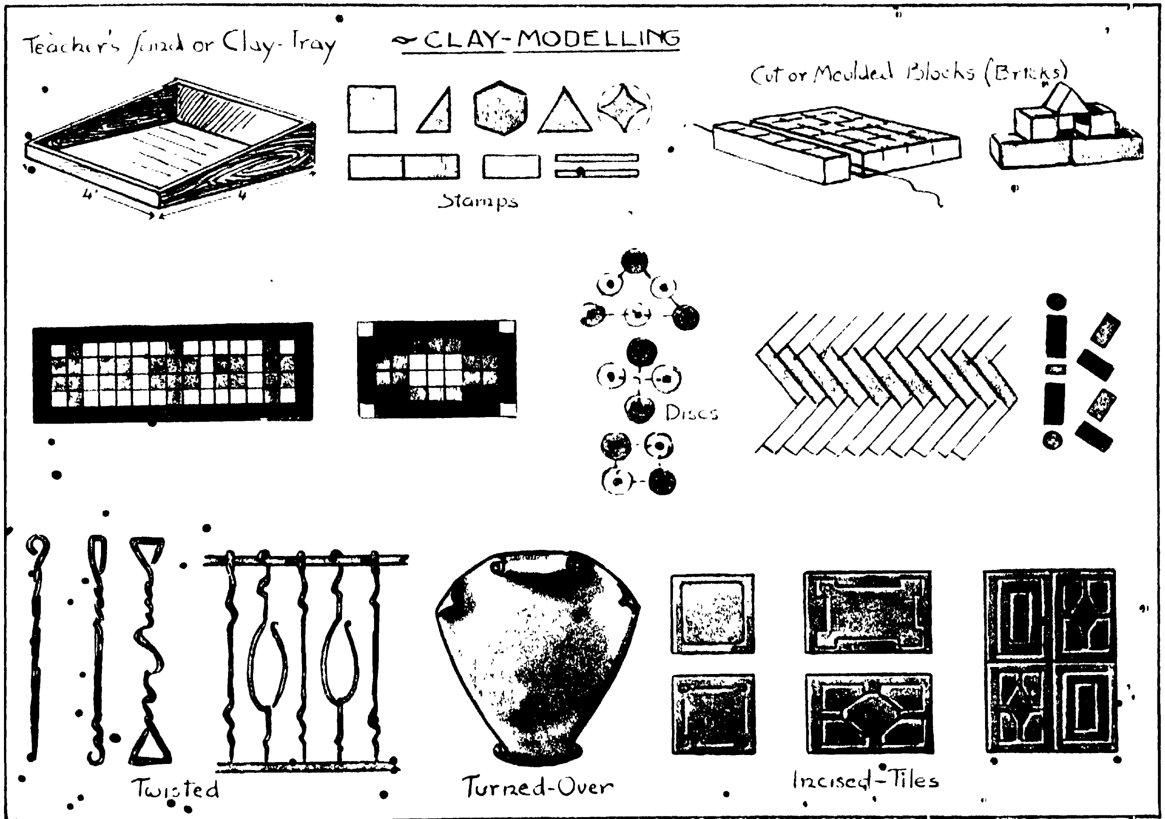
Quantity for Each Child.—From a quarter to a half pound of plasticine will, generally speaking, be sufficient per child, and for hygienic reasons each child's portion should be stored in a small tin box. If clay is used it should be disinfected from time to time.

Tools. Very little more than the finger and thumb is required. The youngest children, however, should not be restricted to these, but allowed the free use of the hand. A wooden tool, pointed at one end and wedge-shaped at the other, would sometimes be useful (see illustration). A sharpened dead match, hairpin, skewer, kindergarten pricker, and pen-nib are occasionally of service.

The modelling board should be varnished. Grease-proof boards and slates also answer the purpose well.

(Plate IV)

Simple Mechanical Processes.—Small outfits of tin Stamps as shown may be found useful at times, and pretty and ornamental patterns made with them. The clay should be first pressed out thinly and then stamped like pastry. The shapes could then be coloured, if coloured plasticine is not used in the first place. Small Tile or Pavement Patterns are shown worked this way. Disc Patterns for counting may also be treated in like manner. A Parquet Flooring is shown of strips (stamped) in two colours.


Teacher's Sand or Clay-Tray
CLAY-MODELLING
Cut or Moulded Blocks (Bricks)
4'
4
Stamps
Discs
Twisted
Turned-Over
Incised-Tiles

Plasticine rolled out, or cut into thin lengths by thin string or cotton thread and then Twisted, produces some wrought-iron effects. Ends may be flattened out into leaf-like shapes.

The Shield is an example of turned-over edges, and is very easily modelled.

The tiles are first made by the scholars, then patterns incised on the surface. Or the pattern may first be drawn as ruler work on paper, the paper placed on the clay slab and the pencil drawn over the line rather heavily. The indentation shows through, and the slab may be touched up slightly afterwards.

The Bricks or Blocks may be cut by a piece of string in the manner of cutting cheese, butter, or bars of soap.

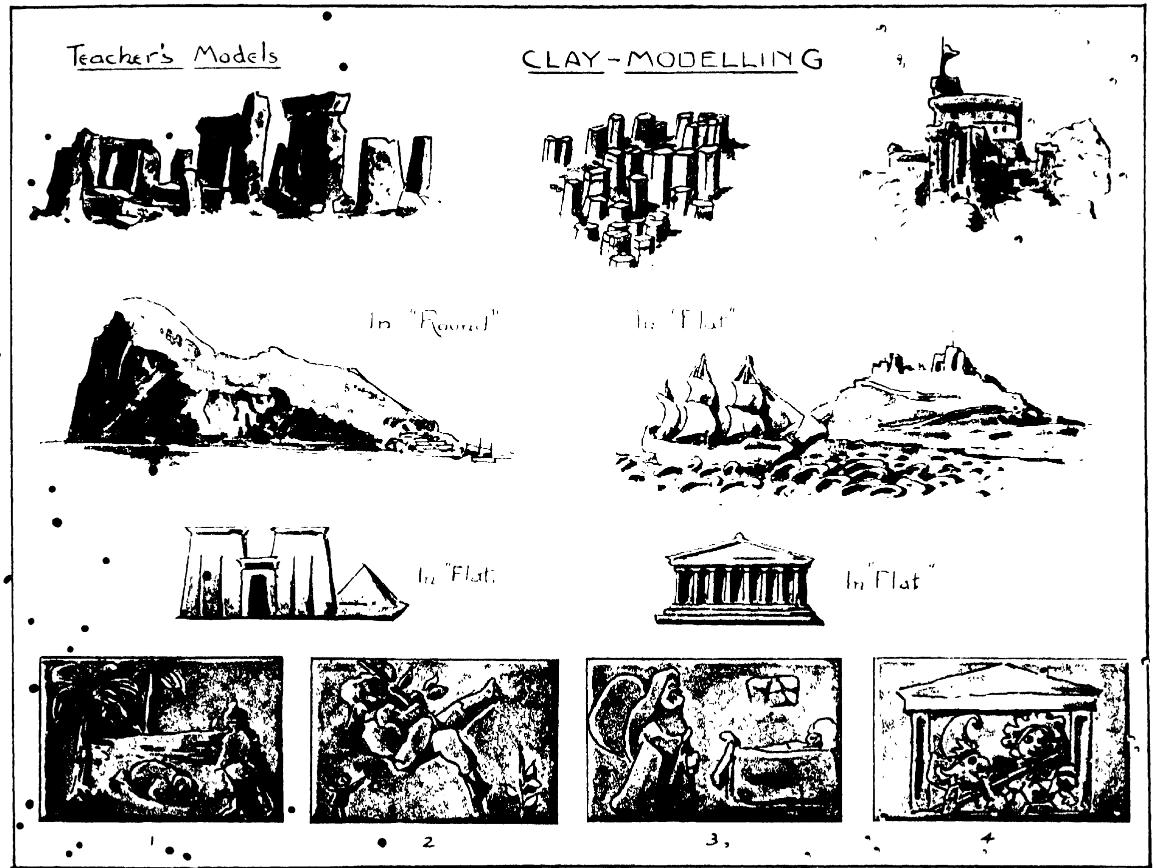
(PLATE V)

Teachers' Models—Historical and Geographical. First are shown some teachers' models in the "round" and in the "flat". Such subjects as the following lend themselves to the "round": Stonehenge, dolmens, cromlechs, Celtic towers and crosses, contour maps, geological strata, cliffs, waterfalls, Giant's Causeway, The Needles, Gibraltar, caves, lighthouses, forts, harbours, coastguard station, observatories, canals, castles, dykes, windmills, and mountain ranges, &c. Pigments may be applied, and little models or accessories (foliage, grass, trees, &c.) may be added.

For the "flat", or "low relief", such elevations as shown are valuable: Windsor Castle, Temples, and others such as Cleopatra's Needle, The Monument, could be suggested.

Fairy Stories.—Below are shown a few children's plaques or story pictures. They are playwork, and may be of any subject discussed. Those shown (1 to 4) are "Robinson Crusoe", "Jack and the Beanstalk", "Santa Claus", "Punch and Judy". They are mainly incised-work, slightly modelled in parts or depressed. Small pointed dead matches or skewers will do for this purpose.

PLATE V


Teacher's Models
CLAY-MODELLING
In "Round"
In "Flat"
In "Flat"
In "Flat"
1
2
3
4

(Plate VI)

The Miscellaneous Assortment merely typifies some subjects which appeal to young children—niggers, gnomes, imps and brownies, bear, Dutch children, Chinaman, waterfall, castle, and boy scouts, "Off for the holidays", flint weapons and pottery, golfer, lanterns.

Other suitable subjects might be: armour of different ages, Biblical and historical subjects, shields, Empire Day, Red Indians, Guy Fawkes, &c.

The bottom row gives a few animal forms in the "round". They may also be done in the "flat". Noah's Ark and small lead, wood, or celluloid animals, which are very inexpensive, may be used as additional models. The animals should be built up in sections (see IX, Plate VIII).

Plaster Casting by Teacher.—Sometimes a little Plaster of Paris Casting is entertaining to the scholars when done by the teacher, and may for all "low relief" models, which are not "undercut", be very easily accomplished.

A very simple beginning may be made with leaves. It is good sometimes when children are modelling leaves to allow them to press a leaf on the soft clay, previously smoothed down into a thin flat slab, to take its impression (A). They may cut round this and leave the shape standing in relief (B). If, however, only the impression is made, a "mould" is formed. Provide four small strips of wood and enclose the leaf slab with four walls. Seal up corners and the under part with clay to make it water-tight (C). Then, in a small basin containing water, sprinkle some plaster of Paris until it nearly reaches top of water. Stir quickly into a cream, and then gently pour over the impression to half an inch or so in thickness, and leave it to set. In half an hour remove wooden surrounds and gently take slab away from plaster cast. Wash the cast if any clay adheres, and a model of the leaf will appear. Of course, anything in the "round" like the peeled apple (D) is too difficult for infant demonstration, as it would require a double mould first.


MISCELLANEOUS
Childrens Exercises
CLAY MODELLING
Plaster Casting

If, however, "a cast" is wanted of a *scholar's model* of a leaf it is not difficult to obtain. First, build round the clay model and get your mould as before. Then brush over mould with sweet oil or soft soap. Finally fill up with plaster of Paris and allow to set. Tap gently until the "cast" disengages itself from the "mould". Superfine or best plaster of Paris only should be used.

PART III

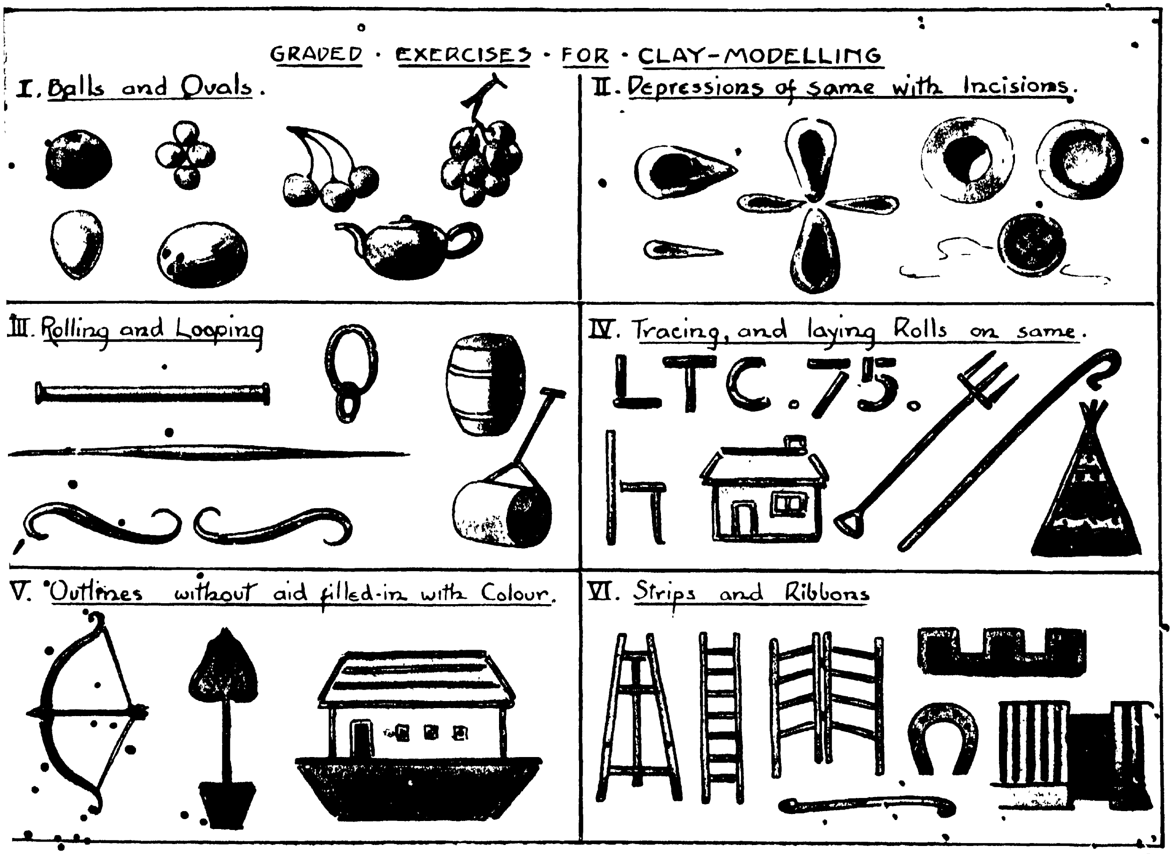
A Simple Course of Clay Work.—This part as has already been stated, is a suggested graduated course of plastic exercises based on the contents of the previous pages, with which it could concurrently run or which it could precede according to the choice of the teacher. The course thus outlined may roughly be said to proceed along these lines:—

(PLATE VII)

1. Balls and Ovals.—Some teachers prefer to deal with the oval form first. In either case, roll plasticine between the palms of the hand, and shape into marbles, grapes, peas, orange or apple, &c., or in the case of the oval form into a plum, lemon, potato, &c. These could afterwards be coloured very effectively and easily. For special note on colouring, see "Useful Hints".

2. Depressions of above with Incisions.—Flatten small plasticine balls or marbles by pressing down with thumb. Disc forms are in this way produced. By depressing and incising with tool, "buttons" could be modelled.

3. Rolls, Loops, and Twists.—Place plasticine between modelling board and hand and roll out thinly. Thicker rolls give the tub and garden roller, using small lengths of twisted


GRADED · EXERCISES · FOR · CLAY-MODELLING
I. Balls and Ovals.
II. Depressions of same with Incisions.
III. Rolling and Looping
IV. Tracing, and laying Rolls on same.
LTC. 75.
V. Outlines without aid filled-in with Colour.
VI. Strips and Ribbons

wire for handle. Other roll forms, such as cucumber, sausage, banana, worm, &c., could be modelled.

Twists could be made like cord, or like looped and plaited string. (See also Plate IV.)

4. Tracing—Rolled Clay on Outline.—Over previously graphed drawings made by the teacher the children trace with rolls of clay.

5. Outlining without Aid.—More advanced children outline drawings with pricker or pen-nib on the slab of plasticine. For methods of making a slab or plaque, see "Useful Hints"—Slab Making. Or, if grease-proof modelling boards or slates are used, an outline in chalk could first be drawn by the scholar and afterwards covered over with thinly-rolled plasticine. Then, if it is filled in and surface smoothed over with the thumb, a "relief" is obtained.

6. Strips or Ribbons of Clay—Curling.—A slab is first made about $\frac{1}{8}$ inch thick, and then cut by mechanical means (thin string or tool) and placed into shape on the modelling board. The plasticine could be curled like shavings or twisted paper.

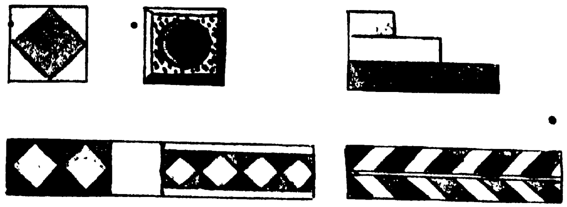
(Plate VIII)

7. Slabs, Tiles, and Bricks.—Brick making can be accomplished by the cutting of strips of clay from slabs. Then by means of cross cutting with a cotton thread the bricks are obtained. A simple contrivance for brick making is shown in "Useful Hints". The exercise is quite within the capacity of the youngest children.

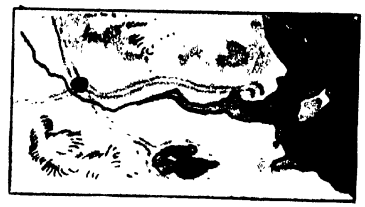
The tiles might be made 2 inches square and $\frac{1}{4}$ inch thick. Incise the tiles as shown, and colour them (see "Useful Hints" for notes on colouring). If the tiles be modelled on small squares of brown paper they could easily be lifted, and the best work grouped to form, say, a tiled garden path.

8. Contour Maps.—The maps are graphed by the teacher for illustrating geographical

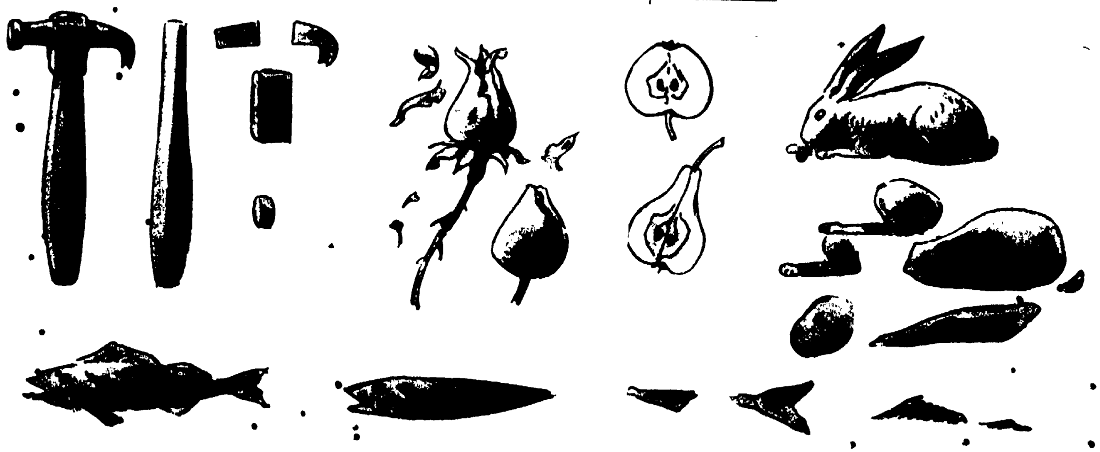
VII. Slabs, Bricks, Tiles (Coloured)



VIII. Contour-Maps



IX. Natural and Common Objects — Structural processes.



terms, and could be well used by Standard I children. The mountains suggest the high land (see that the relief is not exaggerated), the river, lake, and sea could be suitably coloured, as also the land. Other effects could be added if necessary.

9. **Natural and Common Objects—Structural Processes.**—It will often facilitate the work if the modelling of common objects, plants, and animals be first done in parts, beginning with the chief feature of the object, and afterwards putting the parts together.

The diagrams show sufficiently the processes. The fruit sections should be modelled in their main masses, and interior effects afterwards added.

For further particulars concerning the Modelling of Plants, see "Useful Hints".

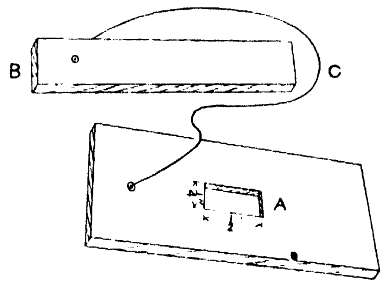
CLAY MODELLING

PART IV

USEFUL HINTS

Powder Colouring of Clay or Grey Plasticine.—Powdered pigments in a variety of colours are easily obtained, and the powder is applied to the plasticine model by using a dry camel-hair brush. The effects are often quite realistic and pretty. Dry colours obtained of any oil-and-colour-man, and a pennyworth goes a long way, well answer the purpose. Should the colour be found at any time not to adhere, slightly damp the brush.

Brick Making.—A very simple wooden device, as shown, will materially assist the youngest in brick making. Fill in the opening at A with plasticine, carefully smoothing over with thumb and removing any surplus plasticine. Push through A with shaped stick B, and a moulded brick appears. The mould A is made about ½ inch by ¼ inch. C is a piece of string which secures pusher.



Slab Making.—Slab making can be done in several ways. Take pieces of plasticine, flatten between finger and thumb, and place on modelling board. Repeat this until a large enough surface is obtained, and then smooth over with thumb. The rough edges can be cut away in order to get a good finish.

Or make a square outline with thinly rolled clay. Fill in a little at a time, then smooth over, and finish as before.

Another method is to place lengths of rolled plasticine side by side, and smooth over.

The slabs should as a rule be about ¼ inch thick.

Baking Clay Models and Colouring.—Instead of using plasticine it may be found necessary at times to obtain a more permanent model. This can best be done by modelling in ordinary clay, placing it while damp on a tin, and then putting it into the gas cooking stove. Supply gentle heat, leaving oven door slightly ajar. In the course of one to two hours it will have become hard. After slowly cooling it can be painted with moist colours. For this purpose mix a little liquid gum with the water colours, and apply with camel-hair brush. A natural gloss is thus produced, and the colour remains permanent on the surface. Such objects as the following can be made to look very effective: Apples, oranges, lemons, potatoes, bananas, carrots, gingerbeer bottle, plates, candlestick, &c. It is hardly necessary to add that the objects, natural or common, should form the copy.

Modelling and Nature Study.—The modelling of flowers, &c., should always be associated with Nature Study, one should aid the other. Specimens should be handed round the class and carefully observed, and if occasion requires the objects should be dissected.

The modelling of **twigs** and **stems** should form the first exercise. The shape and size should be carefully noted, and a thin roll of clay shaped and sized accordingly, observing any tapering, depression, or irregularity. Then model the branching stems, particular care being given to the **growth** of the smaller from the larger. **The articulation of one with the other is very important.**

The **leaves** should be modelled separately. The pupil takes a piece of plasticine and models it out flat between the finger and thumb. Upon this he impresses the leaf to be copied, and cuts away the surrounding clay. Incise veins with pen-nib, carefully attach to stem, and give the leaf any curl that may be necessary.

Another method is to flatten out a piece of clay and draw upon it with pen-nib the shape of the leaf, cut away surrounds, incise veins, and finish off as before.

The **leaf buds**, as the children will observe, are unfolded leaves. In the modelling of them let this point be carefully noticed, and nature imitated as nearly as possible.

The modelling of **flowers** is best done in section.

Exercises should be given in the modelling of fruit sections, as shown in No. IX, Plate VIII, and also such examples as open pea pods, beans, &c.

When the modelling is completed a more natural effect is produced by colouring the plasticine with pigment powders of different colours, or differently coloured plasticines may be used in the first place.

Fairy Stories. This modelling is purely "expressional", and would be done in the "round" or "bas relief". This descriptive work should follow the telling of stories by the class teacher. Some little children might have much to say about their own little models when left to themselves.

If the work be co-operative it should be completed on the teacher's large modelling board. The class could be divided into groups, and the best samples of expressional work from the several groups should be selected to provide the large model. By this means the whole class can be occupied and the best workers rewarded. The teacher might supply the background.

History, Geography, and Object Lessons.—Simple history and geography stories told the children could also be illustrated in the same way. The teacher prepares the large board, and provides perhaps some appropriate background. The class, again, is divided into groups, and the best expressional work from each group finds a place on the large modelling board. The children themselves suggest where to place the models.

Some Object Lessons should be treated in a similar manner.

Clay Modelling in Manual Training

F. W. FARRINGTON

This section has been compiled in order to supply a strongly-felt need in our schools for some form of manual training for those classes hitherto unprovided for, namely the lower standards between the Infant School and the upper classes in our Senior Departments.

Although primarily designed for those intermediate classes, the scheme of work herein contained will be found suitable for *all* the standards.

Clay or plasticine is the medium adopted, as this plastic material supplies a common ground for such practice as will be found preparatory to various handicrafts in different substances, such as wood, metal, leather, stone, &c.

The exercises, all based on common objects or decorative forms, are shown in *plan* and *elevation*, or *section*. This salient feature of the book (more prominently dealt with in Parts II and III) enables the scholar to view the object or design in mass or in three dimensions, which is after all the great secret of true modelling.

My grateful acknowledgment is due to Mr. J. W. T. Vinall, A.R.C.A., for his Introduction, and also for his valuable assistance in the selection and arrangement of plates, and his expert advice.

F. W. F.

NOTE ON GENERAL PRINCIPLES

The title of this section clearly indicates both its scope and its limits. The term "Manual Training" is taken in its widest sense, and not as confined solely to "Woodwork". The training of the *eye* and *hand* is before all things sought after. In this light a new use is found for "Modelling" in our public schools; an old subject is dealt with in a new and very practical manner.

Modelling has always taken, and will always take, its place as one of the highest forms of artistic training; and hitherto it has generally, in elementary work at least, been viewed exclusively in this artistic aspect.

Yet it has a simpler and less ambitious side, another use amongst its several uses; namely, that it may in a more mechanical sense of the word be made the medium for real manual-training exercises. For, it will be admitted, the producing of solid concrete models from working drawings affords suitable practice for those who are to become apprentices, workmen, and handicraftsmen; practice in which too much thought need not be given to higher "technique", or to the striving after artistic effect, when it is not wanted.

Let it not for one moment be imagined that it is herein proposed to substitute this more mechanical side for the more artistic, or to advocate the production of models from pictures and diagrams, rather than from natural forms copied direct from nature. This

course is not intended to infringe upon the uses of clay modelling as a means of nature study and of artistic training, but to supplement this educational function of modelling, by directing the training to a practical end.

The main object of this specific phase of training in modelling should be to open the eyes of the scholar to the possibilities of plastic work for general purposes, and to make him handy with his fingers, thereby leading him to value the clay or plasticine as an easy and enjoyable medium for expressing his ideas in concrete form.

It will readily be seen that such a combined scheme of "nature" and "mechanical" modelling most completely follows out the simple initiative kindergarten stages, as practised in the Infant School. Whereas in the lower school the exercise is mainly intended first to awaken the child's perceptive faculties and interest in the world around him, and then to teach him to express his observations in a simple general manner without too great a dexterity of touch being expected; in the upper school this course is still pursued, but with the *added aim of securing greater precision of manipulation*. And it is to aid in imparting this greater precision of touch, greater skill and deftness, greater exactitude and *originality*, that this set of exercises has been prepared for children above the age of Infants.

The outcome will be that the scholar at the top of the Senior School will be doing quite as wide a range of exercises as when he was in the Infant School, only he will be doing them far better, with all the added skill and power which proper systematic training has given him. He will have learnt how to put *knowledge* into his work, and, after all, that is what is meant by "education".

The author's theory is simple and to the point. He reasons thus. A boy is given a piece of wood, some tools, and a plan and elevation, and he is set to work making joints, tenons, and mortices, &c. Likewise, let a boy be given a piece of clay, some tools, and a plan and elevation, and let him produce a tangible model of the object required. Some-

times the original may be at hand for reference, sometimes it may not; that does not much matter. He creates.

This view of the question is a reasonable one, and is strictly practical. For note: All modelling—the true rendering of concrete form,—however highly developed or complicated, is obtained by tracing over the surface of the clay or plasticine an infinite number of profiles or contours, until every *outline* from every point of view is correct. It is "drawing" in the fullest sense of the word—drawing increased sevenfold. The thing modelled has to be viewed from all points. Thus many views are necessary, but two are absolutely essential—the plan and the elevation,—and if the modelled object prove to be correct in its plan and elevations, that is proof that it has fulfilled all conditions and is true in relief.

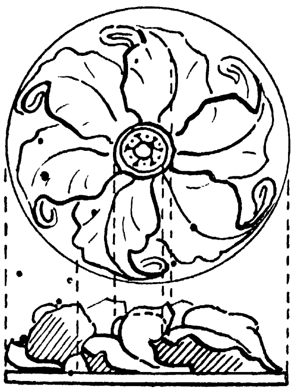


Fig. I

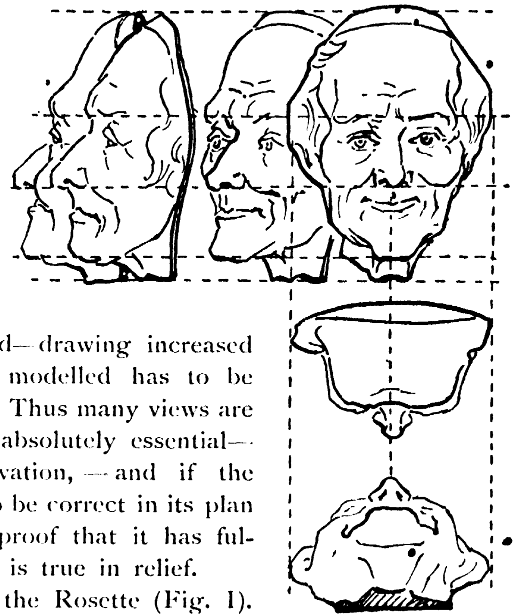


Fig. II

Take, for instance, the Rosette (Fig. I). It must look right not only viewed from the front, when the whole circular plan is seen, but from above, beneath, and on each side, when the elevation should appear true from every direction.

Or again, the same principle is applicable even in such higher forms as the human face or body. In Fig. II, representing the well-known mask of Voltaire, the front view (or facial plan) and profile (or facial elevation) are absolutely essential to the modeller; and all sections in between and in addition thereto—three-quarter views, downward and upward plans (forehead seen from above, chin seen from beneath), become still further aids to the complex rendering of such a high and varied type as the human face.

In illustration of this principle, one has only to call to mind that popular and interesting picture of Charles I, in Windsor Castle, painted by Vandyke, showing that monarch's head in three postions, front, profile, and three-quarter view. It was produced in order to be sent to Rome to furnish the sculptor Bernini with all the essential *data* on which to execute a bust of the king. This, it is needless to say, was quite successfully carried out from the picture.

Hence our author's principle needs no defence, for it is eminently "practical". Supply the scholar with intelligent pictures (*orthographic* representations and not merely perspective renderings) and he should be capable of producing, within the prescribed limits, adequate models of the subject depicted. Let him even *design* them for himself.

Obviously this "picture" method cannot be applied to nature study or highly developed ornamental and sculpturesque forms, but indeed such a *rôle* as this is not claimed for it.

For the rest, the following plates will themselves speak most forcibly as to the utility of the method.

J. W. T. VINALL.

HINTS TO TEACHERS

It is not suggested that the already existing Time Table should be added to, but rather that it should be rearranged, a task which will be willingly undertaken by those teachers who realize the importance of manual training.

EQUIPMENT FOR CLAY-MODELLING CLASS

ESTIMATE FOR CLASS OF 42 SCHOLARS[1]

	s.	d.
3½ doz. millboards, 12½ in. × 10 in., at 9*d.* per doz. - - - -	2	7½
14 lb. of clay, at 2*d.* for 7 lb. - - - - - - - -	0	4
3½ doz. modelling tools, at 11*d.* per doz. - - - - - -	3	2½
Total cost - - - - - - - - -	6	2

If tin trays and plasticine are required, the cost would be as follows:—

Tin trays, 12 in. long, 5*s.* 4*d.* per doz.
Plasticine, grey, red, blue, or yellow, 6¾*d.* per pound.

Plasticine is ordered in pounds, and 30 to 40 lb. are sufficient for one school for a year. Each pound or bar can be cut into four or six parts, each portion being enough for one

[1] The prices here quoted are taken from the Requisition List of the London County Council. The ordinary retail prices are of course considerably in advance of these figures.

child. Clay is usually bought by the hundredweight. If clay be used, allowance must be made for wastage.

Time to Devote to Subject. An hour each week will probably be found a suitable length of time.

About Clay and Plasticine. A word of caution must be given about the use of clay. Much depends on its workable condition. It must be neither too moist nor too dry. If kept in buckets it should be made up into a big ball and a moistened cloth laid over it, which should be sprinkled well with water at least once a day. Superfluous moisture will then collect below the ball, whereas if the clay is allowed just to fill the bottom of the bucket, and becomes slightly scooped out in the middle, the water collects in this hollow and causes the clay to become too moist and sticky, and therefore quite unworkable until it has been allowed to dry for a long while—which is a waste of time. Occasionally a little white sand should be worked up into the clay to improve its texture, and now and again it is advisable to syringe the clay with Sanitas or other disinfectant water.

Plasticine is superior in many respects to modelling clay, but is more expensive It is tenacious, ductile, and elastic in character, can be preserved for any lengtn of time, and does not require damping. It can be had in varied colours, and in the best makes is antiseptic. In many schools it is customary for each pupil to have set apart for his own exclusive use a certain quantity, kept in a small bag. This plan is to be commended.

Plasticine should be stored in a cool place and protected from all dust.

Tools, &c.—The fingers can do most things, but not everything. Only a few tools are necessary, however. A ruler, or penknife, or pen and pencil-point will do much. Then the four tools here shown, Fig. III, *a*, *b*, *c*, *d*, are more than sufficient; and of these *a* and *b* will best serve—*b* for drawing a line or marking a sharp hole (Fig. IV, *b*); and *a* for rounding

a surface (Fig. IV a^1), or scooping a hole (a^2); *c* is mainly for making textures (see Fig. IV, c^1); *d*, a wire tool for lifting superfluous clay (see Fig. IV, d^1). A *penknife* will slice

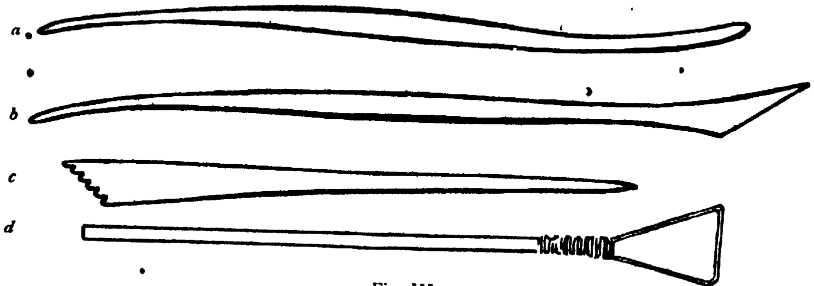


Fig. III

Fig. IV

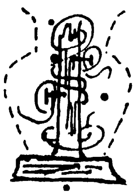


Fig. V

the clay cleanly, and a *ruler* will plane down a flat ground to a smooth face.

Models can be made up on tin trays, slates, or on pieces of thick paper placed on the desks, on old millboards, or any odd pieces of wood.

For very large solid models it is best to pile the clay round a rough wood support, which can have projecting nails or tacks driven into it, and thin wire wound about it. This will afford a good support and hold for the clay. See Fig. V.

A small damp sponge or cloth to moisten the fingers is a great advantage.

Method.—The true process of modelling is not moulding, pounding, and cutting, but consists of a gradual *building up* of the form by superimposed pieces of clay pressed upon

and drawn over the original rough core. As details are added, the pellets used become tinier and tinier, until every unnecessary hollow disappears from the surface. This constitutes true "finish". To wet and polish a surface is bad. A completed surface should be slightly dry and granular, and not shiny. Fig. VI shows the four stages in the modelling of an apple. First the rough spherical core, approximating to the shape, but rather smaller, and rolled in the hands. Then thin strips of clay placed to mark the main ridges; a pellet being placed on the clay, pressed to make it adhere, and dragged into the strip. Next, the hole well scooped out with a tool and the surface worked carefully into it. Lastly, by degrees, is produced the finished slightly conical product—*built* into this shape, not *pressed* into it.

Fig. VI

Models may be in various degrees of relief: (1) intaglio—sunk-relief, (2) cameo—slightly raised or low-relief, (3) middle-relief, (4) high-relief, (5) the round—entirely free. Most of the examples in this book are in round or low-relief, and unessential details are suppressed.

Handling.—If reference is made to Fig. VII, most of the actions in modelling are easily distinguishable: (1) Rolling a lump in palms of hands, (2) rolling a tendril or stalk on table top, (3) rolling pellets between forefinger and thumb preparatory to (4) placing it on main lump, followed by the downward dragging movement (5). No. (6) gives the thumb action in pressing on a large strip requiring stronger pressure. (7) depicts the rolling of a thin form in palm of the hand, such as a cup handle. (8) shows the thumb scooping out a hollow. (9) and (10) show how a line is drawn on the surface by the short edge of the triangular tool, in two actions. (11) depicts the use of the ruler in dragging off superfluous clay and obtaining a plane surface—the ruler resting on the two side edges of the wood frame.

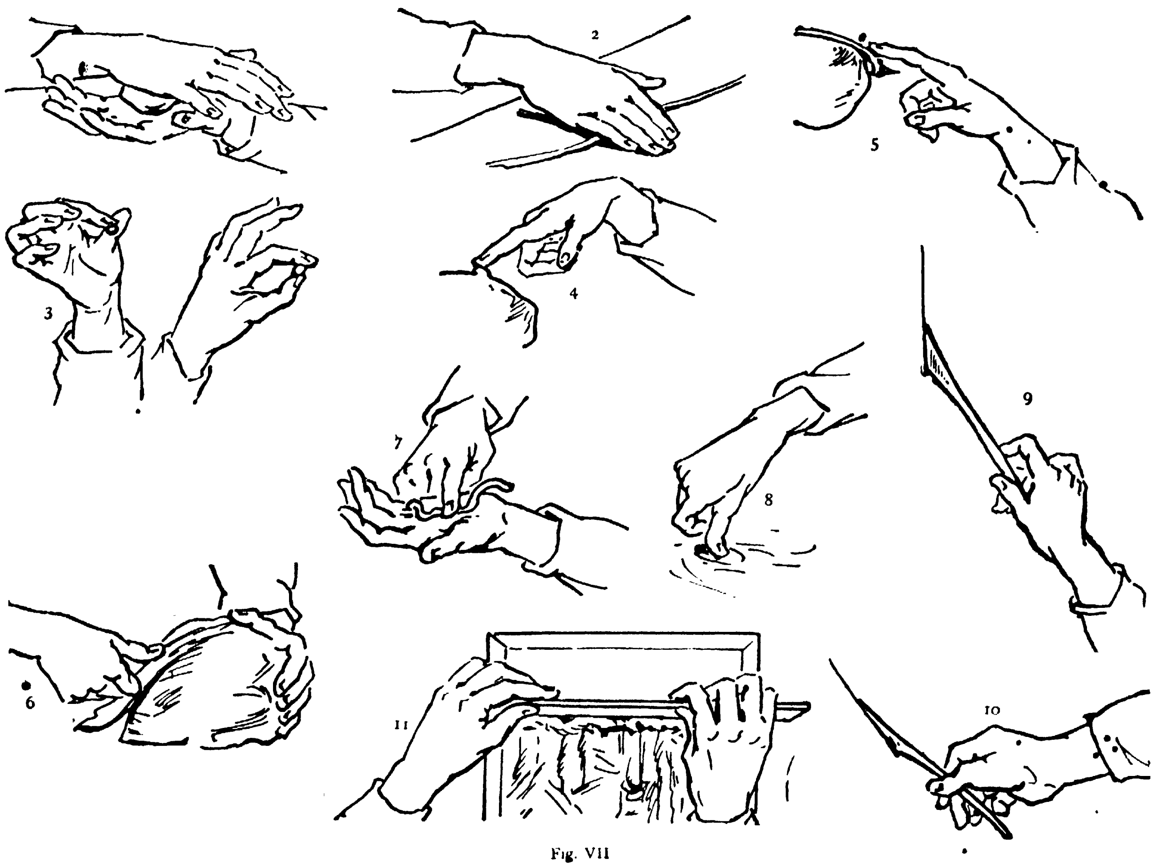


Fig. VII

Position of Modelling Board.—It is of course assumed that the pupils will occupy their ordinary school desks, and that the work will be done on boards, slates, or tin trays lying in a horizontal position.

Should opportunity or necessity arise for tilting the board upon which the pupil is to work, or placing it in a vertical position, it could be kept in the desired position by resting it against a slate or board placed in the slot of desk.

How to Start a Class.—Provide each pupil with the necessary tools and ruler; a piece of chalk may also be necessary for outlining the ground plan. Then give to each scholar a slate, tin tray, or thick millboard. Large millboards cut into four have been found a convenient size (about 6 in. by 5½ in.), as, not being too large, a few of the best models can be kept if desired. A piece of clay or plasticine about the size of the scholar's fist should be given him.

The millboards, clay, &c., having been distributed, each pupil is given his handbook, and, in order to foster self-reliance, neighbouring pupils should as soon as possible build up from a few different exercises.

How to Use the Plates.—These are actual working drawings. They are considerably simplified, being meant to show the general mass only. The exercises are drawn to scale so as to allow of easy and convenient enlargement, adaptable to the amount of clay supplied to each pupil. They are grouped into Junior, Intermediate, and Senior Sections.

It is not strictly necessary that these exercises should be taken consecutively; selections may be made at the discretion of the teacher. The greater number of the plates explain themselves, and as progress is made fewer hints will be needed from the teacher. In the earlier stages, however, it will be necessary, before starting the class, to give the scholars such explanations of the plates as are provided in the Explanatory Notes.

Any available or suitable means can be employed by the pupil in working his exercises. For this reason, although fingers will accomplish most things, the scholar should have no hesitation in using his tools when necessary, freely using his ruler for enlarging the proportions given in the copy. This applies equally to the elevation or thickness, and to the plan.

MEMORY PRACTICE

Memory exercises in modelling should be brief, but regularly and methodically practised. They are not primarily the reproduction of work formerly done, but rather the memory renderings of objects or nature specimens immediately viewed and then removed. The scholars should first of all be requested to examine the specimens thoroughly, carefully estimating proportion and construction — the teacher possibly giving a few hints. From ten to twenty minutes should be allowed for the exercise (no finish will be expected), and the results should afterwards be compared with the originals.

Original *creative* work in this connection could also be encouraged, e.g. the construction in miniature of a fort or bridge.

MODELLING OF COMMON OBJECTS

Although the exercises in this book deal for the most part with the modelling of common objects from plan and elevation, it is not to be supposed for one moment that the

value of modelling from actual objects or from nature is in any sense underrated or minimized. On the contrary, its educational value, as the true basis of all sound instruction in this subject, is fully recognized, and it is recommended that every effort be made to supplement the scheme of work outlined within these pages, by giving practice in modelling direct from nature or from common objects.

In the kindergarten class, it is true, the young scholars model mainly, if not entirely, from common objects, but these exercises are merely intended to foster sense expression. The object *impresses* the child, and the child *expresses* the object. Sense of proportion is not expected at this early stage. But a period arrives, and our conclusion is that it comes at about the time a child of seven or eight is transferred to a senior department, when the same exercises already practised have to be dealt with in a more serious manner, when correct observation should express itself in something like right proportion and exactitude.

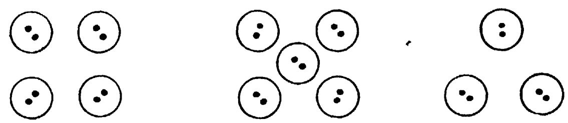
In other words, there comes a phase in the child's school life when a definite amount of practice in technique is demanded. This stage is known in child study as the "Drill Period". And if kindred arts demand this technical training, why not admit the claim of clay modelling to the same method of treatment? Granted, then, that the manual and technical part of the child's instruction is indispensable, the question arises: To what extent can this be carried out? Now, as the course here recommended claims to be nothing if not practicable, we are at once confronted with two almost insuperable difficulties, viz. the size of the class and the inaccessibility of objects suitable and sufficiently numerous to provide copy for each individual scholar. It is to meet these difficulties in a really practical manner that these plates have been prepared. The scheme of work here presented claims to provide through clay modelling a course of manual training that is of high educational value.

Natural forms find a certain place within the pages of this book, but they are only used as elements in decorative work, and are interpreted in a conventional style, when greater

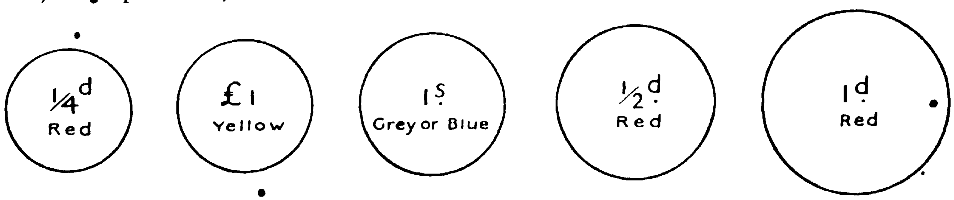
latitude is permissible. This will be seen from the exercises as shown on Plates XVII and XXIX.

MODELLING AND PRACTICAL ARITHMETIC

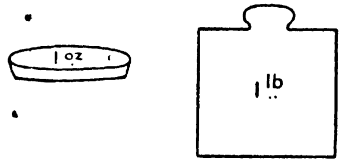
In a very practical manner, and with considerable interest to the pupil, clay modelling may be used to advantage in dealing with arithmetical problems. It can be made to demonstrate numbers, areas, volumes, &c., and by using coloured plasticine the exercises may be indefinitely varied.



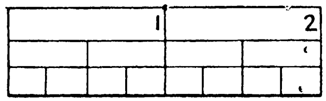
Little balls or buttons of clay may be utilized for illustrating simple exercises in addition, subtraction, multiplication, and division.



In like manner money values can be shown, say, by four or five coloured plasticine disks, representing pennies, shillings, sovereigns, &c.

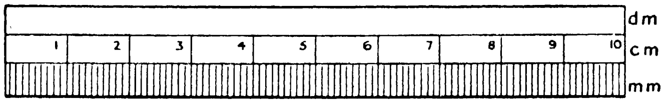


Similarly masses of clay representing relative weights may be modelled, illustrating the relation of area, bulk, and weight. Simple exercises on these lines will readily suggest themselves to the teacher.

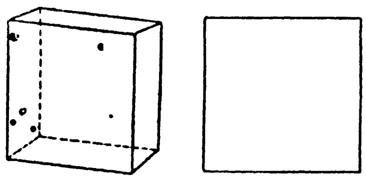


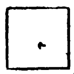
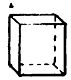
Rules of varying lengths might also be modelled in clay, and in the upper standards the modelling of a protractor or a decimeter measure would afford interest and practical instruction.

In the teaching of Fractions modelling is particularly useful, as the relation of the part to the whole can be so graphically illustrated by the use of clay.



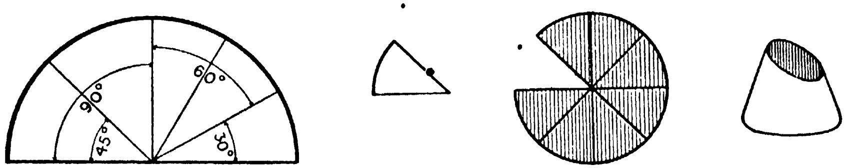
Then in regard to the measurement of surfaces, &c., clay can be profitably used. Thus, for example, a line of clay would represent an inch in length. A thin layer of clay, shaped as here represented, would be a square inch, whilst a solid, as shown to the left, would clearly indicate a cubic inch. In like manner metric measurements might be treated: the centimetre



——, the square centimetre , the cubic centimetre .

The mensuration of rectangles, irregular figures, triangles, solids, and circles can also be dealt with in a thoroughly practical manner.

Then, again, the solid geometrical forms, such as cube, cone, cylinder, &c., can be easily made in clay, and their various sections illustrated.



MODELLING AND GEOGRAPHY

For the teaching of physical geography, clay, or preferably coloured plasticine, is invaluable. Fascinating models of land formation, mountains, rivers, lakes, coast line, capes, &c., can easily be modelled in projection.

In the upper classes the scholars could readily model in relief a map or section of a map illustrating some part of their geographical course, and showing the relative height of mountains, the course of rivers, and the position of towns, &c. *Military cadets*, in our public schools, might experiment in the construction of miniature earthworks and trenches.

Clay models may further be used for illustrating the shape of the earth, day and night, and the seasons, and globes may be modelled showing zones, and the raised portions of the earth's crust.

To produce a relief map the shape of the country must first be sketched in chalk on a hard ground (in not too great detail), e.g. on a millboard or slate or piece of thick paper. A thin layer of green, yellow, or brown plasticine is then spread carefully over the whole

shape and the edges cleanly trimmed with the tool or knife to the original outline. Then the mountain ranges should be built up in irregular form, and all the intervening surface gone carefully over with reference to its physical features. Snow-capped mountains could be touched up with some white powdered chalk, and towns could be shown by dark-brown plasticine projections, buttons, &c.

Lastly, the sea and lakes represented by the hard original ground, could be rubbed over with blue chalk.

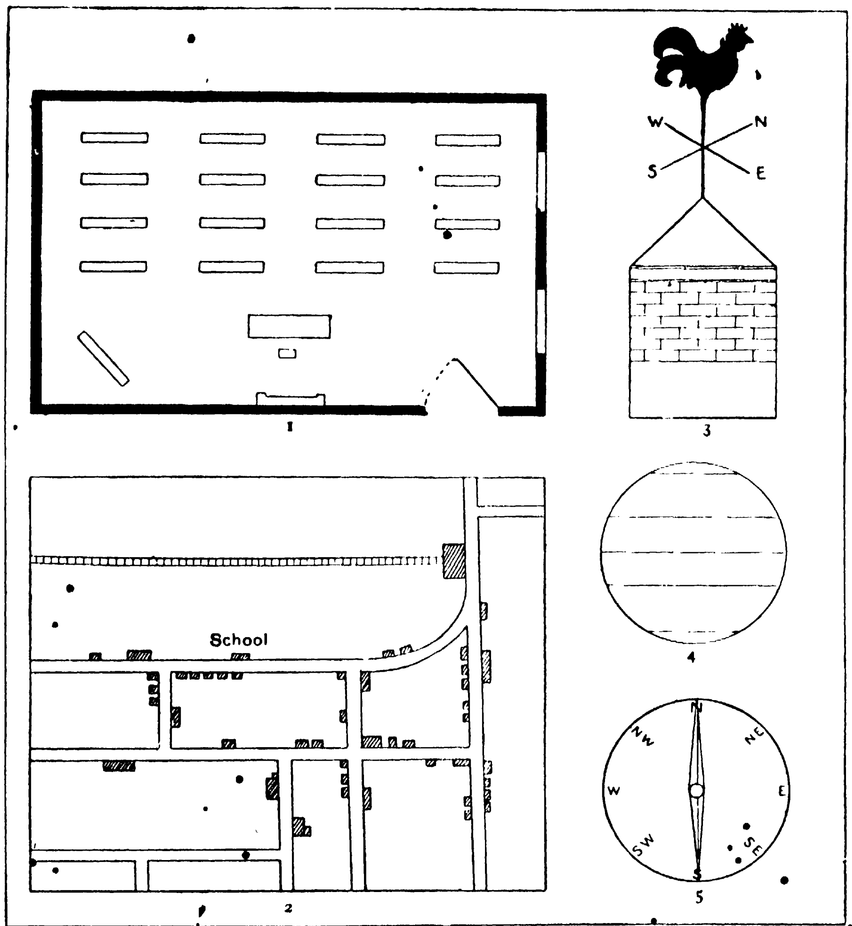
Lengths of rivers and watercourses could be indicated by incisions in clay ground, and the world's mountain heights could be relatively shown in clay relief from the sections indicated in all atlases.

CLAY MODELLING IN ITS TWO ASPECTS

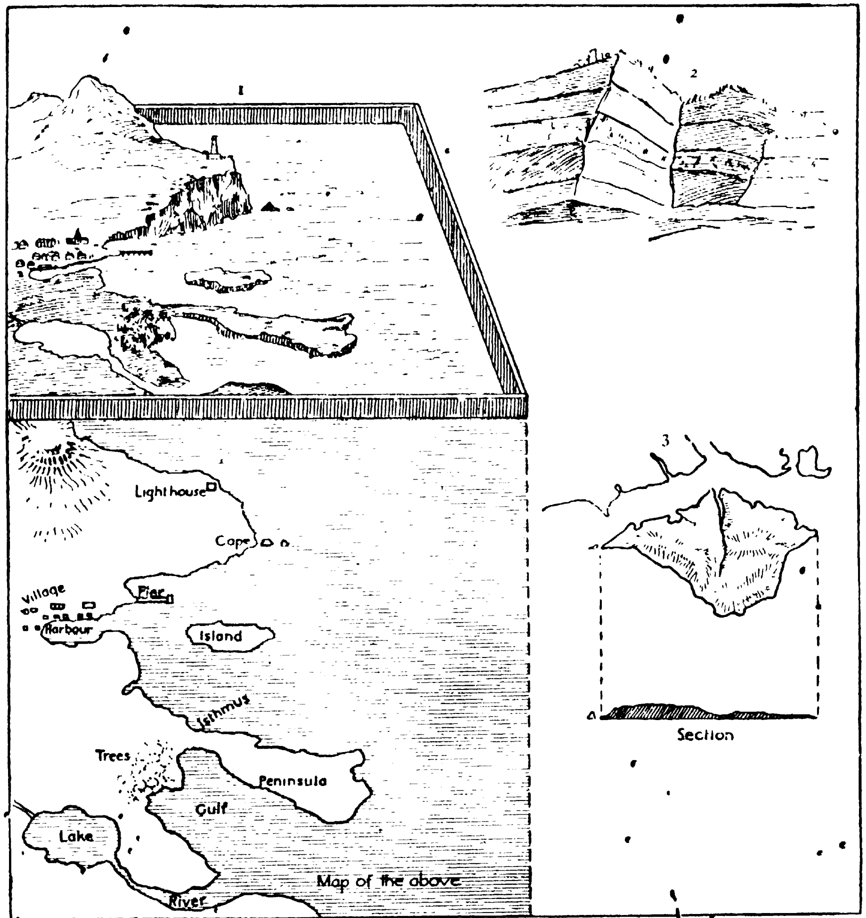
CLAY MODELLING

- IMITATIVE
  - Impressional
  - Pictorial
  - (Nature Forms and Realistic Representation)
- CREATIVE
  - Constructional (Solids)
  - Inventional (Plastic Design)

Mechanical Modelling linked with Mechanical Drawing thus constitutes a Creative Form of Manual Training.



Modelled Geographical Illustrations of (1) Plan of Schoolroom; (2) Plan of School neighbourhood; (3) Weathercock showing cardinal points; (4) Earth's Zones; (5) Compass.



Modelled Illustrations: (1) Geographical; (2) Geological; (3) Relief Map.

GLOSSARY OF TERMS

The terms used in the plates are simplified renderings, so that the scholar should become thoroughly familiarized with them—such, for example, as: "round relief" "half relief", and "flat relief".

Here follows a list of terms with which it is necessary the pupil should become acquainted, if not in the lowest classes, at least in the upper. These terms are:—

Abacus, the upper table crowning a column and its capital.

Alto relievo, high relief.

Basso relievo, low or bas relief.

Cameo, very low relief cut upon an upper layer, an under layer forming the ground.

Elevation, side view, front view, end view, thickness.

Gesso, ornament modelled in hard paste or wood on other background in very low or middle relief.

Incised, surface only very slightly scratched by drawing the triangular tool lightly across clay.

Intaglio, sunk relief, i.e. ground cut out.

Mezzo relievo, middle or half relief.

Mouldings:—

Cavetto, simple concave curve (see Plate XXVI).

Cyma recta, ogee curve; top half concave, bottom half convex (see Plate XXVI).

Cyma reversa, ogee curve; top half convex, bottom half concave (see Plate XXVI).

Ovolo, oval or egg-shaped (see Plate XXVI).

Pierced, groundwork cut right through and away with any sharp tool.

Plan, top view, or view at right angles to the direction of vision. Often interchangeable with "Elevation".

Projection, distance outwards right or left from a line drawn through an object.

Relief or relievo, the prominence of the object above or beyond the ground.

Repoussé, metal ornament hammered from behind in low relief.

Round relief, free objects disconnected from background.

Scooping, a slight digging out of clay with the blunt round-ended tool.

Sgraffito. In plaster work two layers of different colours are sometimes superimposed; ornament is then outlined on the upper layer, and the groundwork cut away exposing the under layer.

Template, a thin wood or metal mould, dragged over clay to produce mouldings.

PLATES WITH EXPLANATORY NOTES

JUNIOR COURSE. PLATES I-XVI

INTERMEDIATE COURSE. PLATES XVII-XXVIII

SENIOR COURSE. PLATES XXIX-XL

JUNIOR COURSE

This part of the book is designed as preparatory to the working of models from full plan and elevation, and is introductory in that it gives practice in the technicalities of clay manipulation. All direct reference to plan and elevation is avoided for the time being. Many common objects are dealt with, but their representation is given in very low relief and not in the round. This latter treatment of objects is reserved to a later period. If, however, a specimen object could be shown the scholars, there is no reason why it should not be modelled in the round.

PLATE I

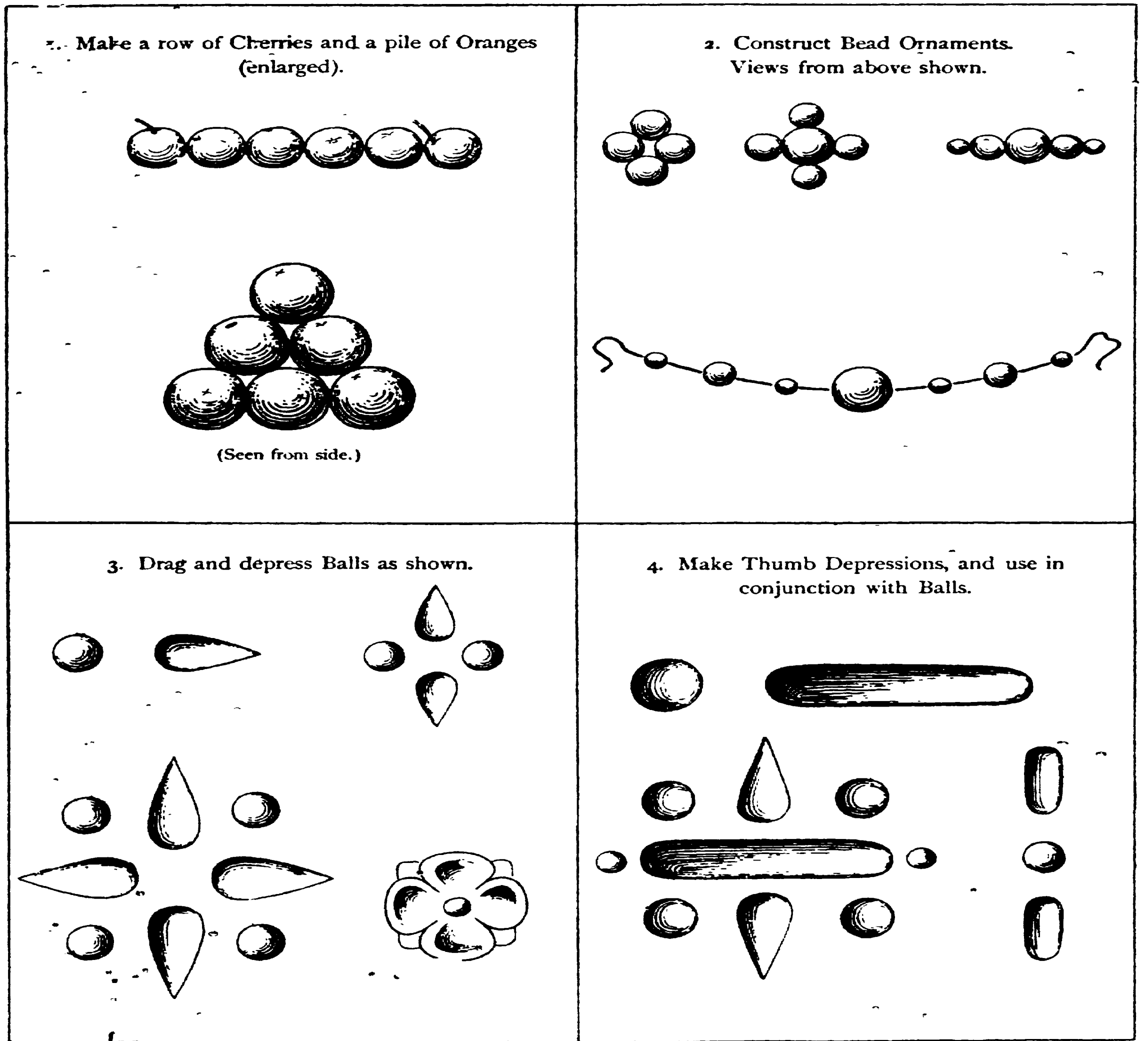

1. Make a row of Cherries and a pile of Oranges (enlarged).
(Seen from side.)
2. Construct Bead Ornaments. Views from above shown.
3. Drag and depress Balls as shown.
4. Make Thumb Depressions, and use in conjunction with Balls.

PLATE I

Exercise 1. Roll pieces of clay between the palms of the hands with very even but slight pressure until a sufficient roundness is obtained, and add stalks to represent cherries.

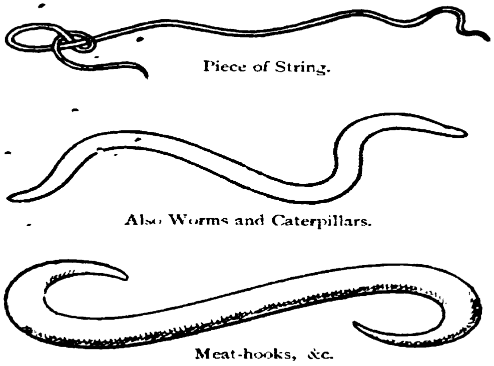
Note that the bottom layer of oranges forms a triangle like the side view shown in drawing.

Exercise 2. Observe the relative sizes of beads, and connect same by a coloured chalk line, or by a well defined incision with the point of the tool. Or the balls might be strung on a piece of string.

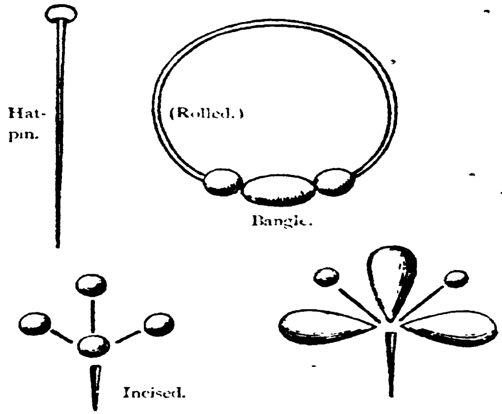
Exercise 3. The depressed spindle shapes of clay are obtained by first making a ball, and then with thumb carefully dragging one half to a point. It will be well to mark the position of balls on ground, and there place the balls before dragging.

Exercise 4. In this plate are other examples of thumb impression and dragging, but this latter process should be done very evenly to avoid tapering the clay.

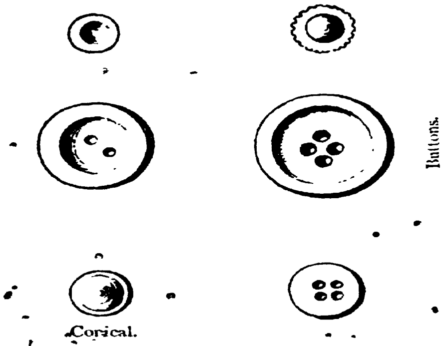
5. Roll Clay into Threadlike Lines to represent String, or other examples shown.



6. Further development of Rolled Forms.



7. Disc Forms (Buttons, &c.).



8. Disclike Forms treated as Biscuits or Pastry Shapes.

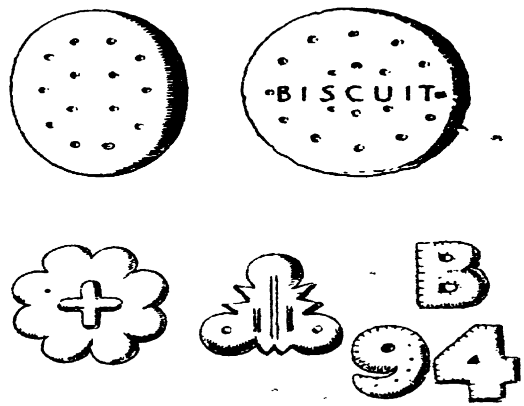


PLATE II

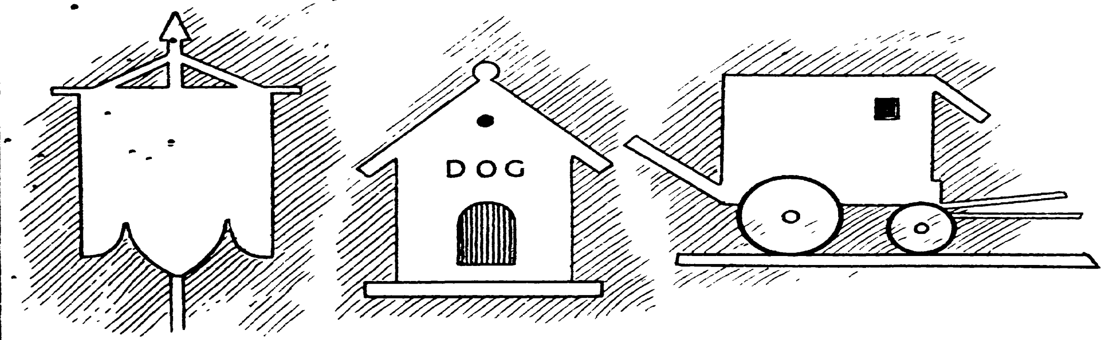
Exercise 5. Here are illustrations of rolled clay. This is done by rolling between the hand and modelling board. With care the clay or plasticine can be drawn out to a very fine line. Knot forms could be designed.

Exercise 6. Further developments of rolled clay are here shown. If necessary the circular form of bangle can be obtained by the aid of a chalk line.

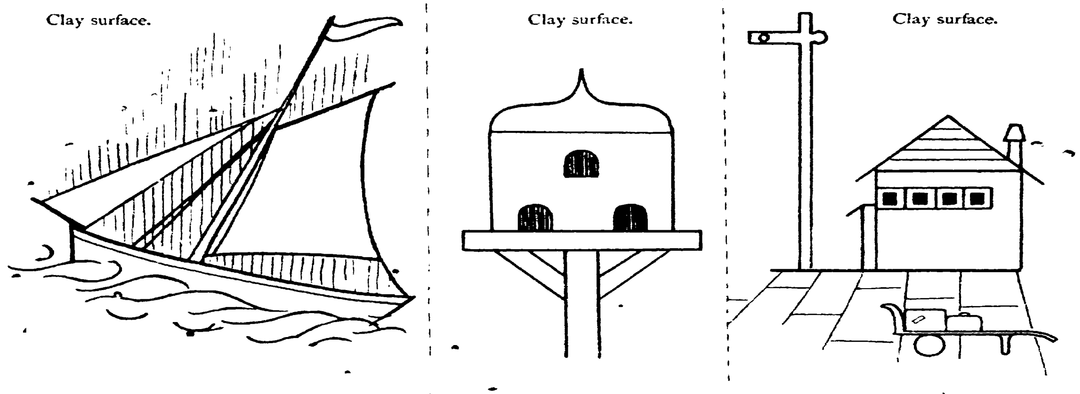
Exercise 7. These are disc forms or button-like shapes. Round a piece of clay into a ball and then flatten and press with thumb until an even shape is obtained. The holes are made with the pointed end of tool or slate pencil. Note the two conical-shaped buttons.

Exercise 8. A few sample biscuits might well be shown the class before modelling from the picture. As a variation, a half-pound of lettered biscuits of this kind distributed around the class would afford excellent practice.

9. Represent pictorially these Examples by Incising Outline on thin layer and cutting away.



10. Pictorial Representations continued: Sharply Incised with Tool.



Note: Windows are cut right away.

PLATE III

Exercise 9. Pictorial representations now follow, and they should be considerably enlarged, two, three, or four times, as the case may be.

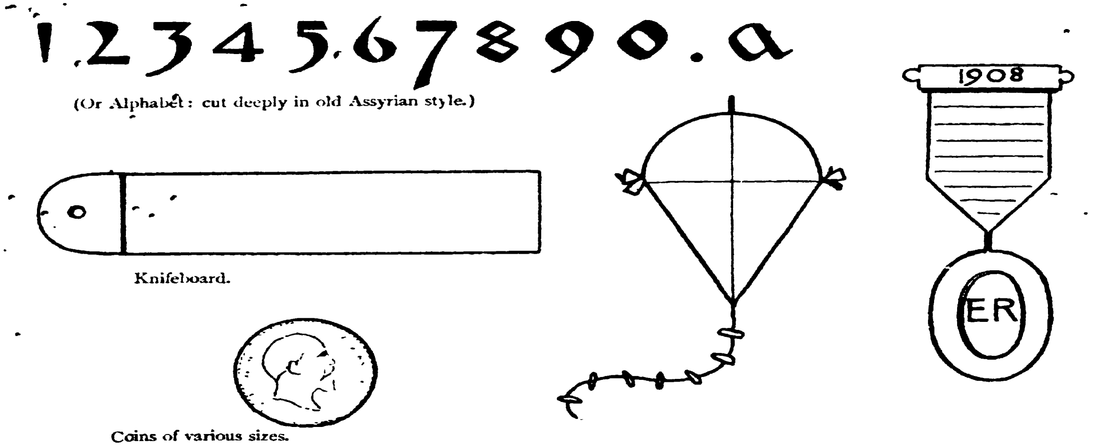
Pupils should first place on modelling board a thin layer of clay or plasticine, smoothing the surface over with flat tool or thumb. This done, with sharpened end of tool incise outline of picture, and then cut away the surrounding portions of clay. Scholars' attention should be drawn to the relief or thickness of what now remains.

To show door of dog kennel, ventilating hole, and window of van, cut clay right away.

It is suggested that all these exercises from 9 to 16 should be treated in the same way.

Exercise 10. These being more elaborate pictures should preferably be merely incised lines on thin clay surface, or the clay surrounding outlines may be cut away. In either case cut away clay to represent doors and window. Dotted line roughly indicates limit of clay bed.

11. Further instances of Incisionwork and Flat-surface Cutting.



12. Shield Forms treated in similar fashion.

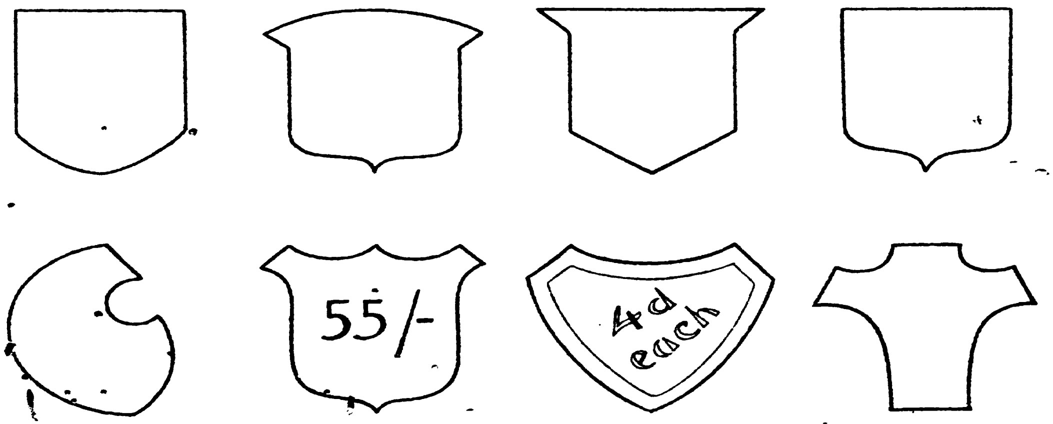
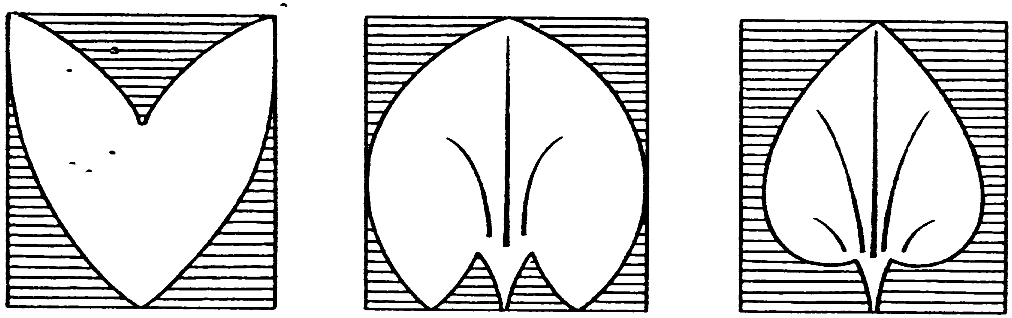


PLATE IV

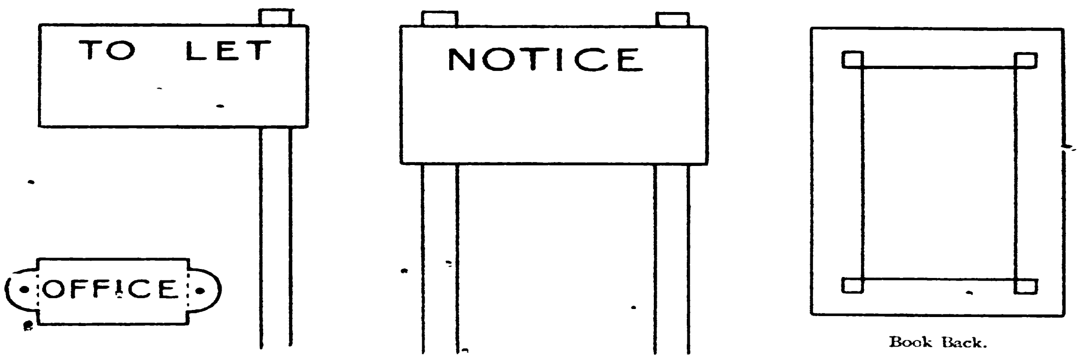
Exercise 11. The cutting of letters and numerals is good practice; the incisions should be deep. They resemble in this respect the early Assyrian characters.

Exercise 12. These shields are flat surfaces, cut out of layers of clay. Shop-window tickets take many of these forms. Edges might be turned over.

13. Ornamental Units for Borders, &c. Construct rectangular bed of clay and transfer Units as shown.



14. Further Flat-surface Treatments.



Book Back.

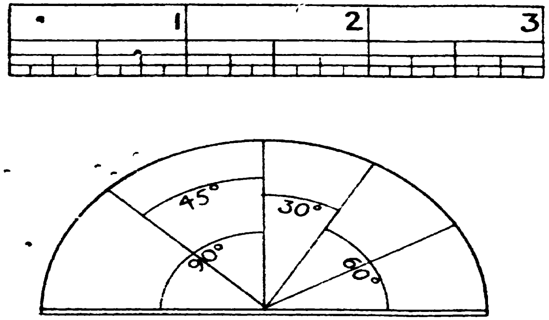
PLATE V

Exercise 13. These are flat surface ornaments suitable as units for repeating borders. The units can either be cut out, or the surrounding background lined as in drawing. These are not freehand copies, but actual constructional forms having thickness and surface treatment.

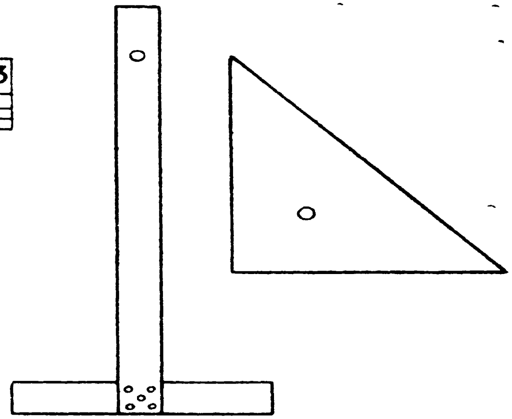
Exercise 14. The notice boards do not project beyond the surface of the posts; they are shown in the same plane for convenience.

The pattern on book-back is firmly incised with point of tool.

15. Construct Models of Simple Geometrical Instruments.



Note: Consult protractor for any further detail required,



16. Series of Simple Borders of Incised Pattern. To be enlarged.

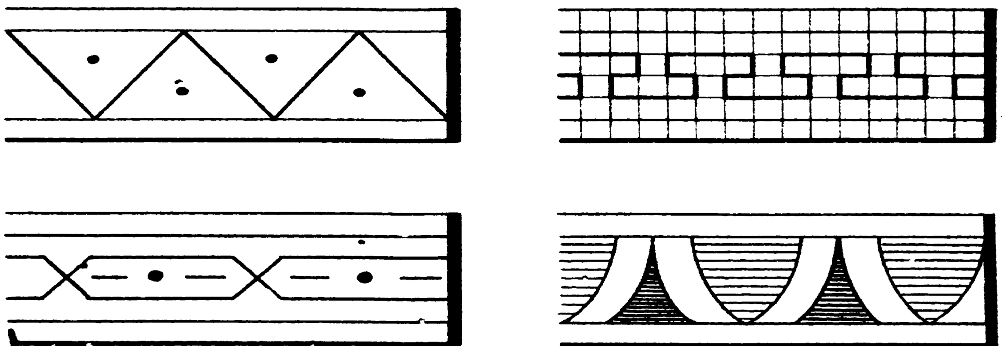


PLATE VI

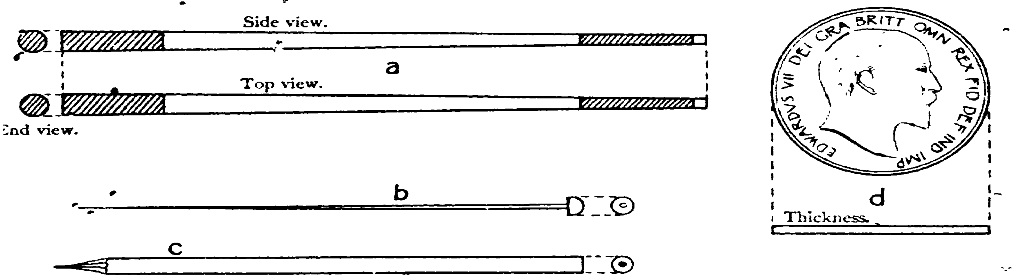
Exercise 15. The head of T-square can be made to project double the thickness of blade.

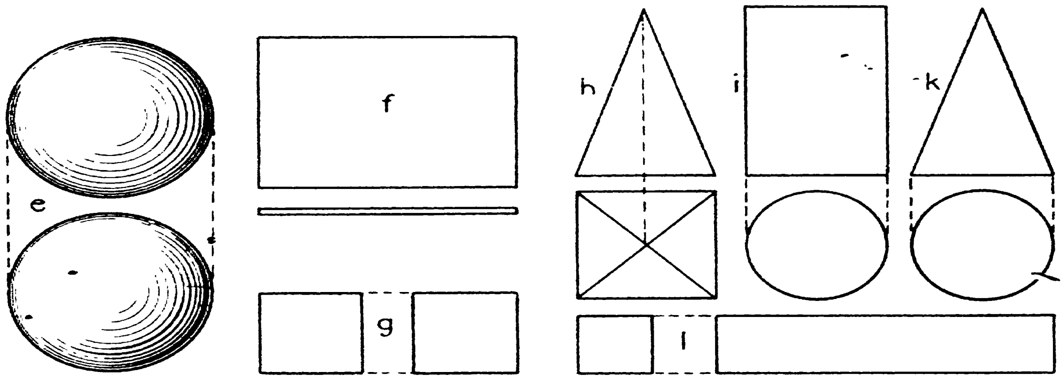
Only the chief angles of protractor are here indicated.

Exercise 16. These are further examples of simple borders.

The lines surrounding each border should be fairly deep incisions made with ruler; other lines should be clearly defined, and where the drawings are darkly shaded, as in the last two exercises, the clay should be cut right away.

17. Illustrations of Plan and Elevation.





Introductory Examples to illustrate the three dimensions.

a, Teacher's Pointer. *b*, Hatpin. *c*, Black-lead Pencil. *d*, A Penny or Coin. *e*, A Ball. *f*, A Millboard. *g*, Cube. *h*, Pyramid. *i*, Cylinder. *k*, Cone. *l*, Bar of Soap.

PLATE VII

Plan and Elevation

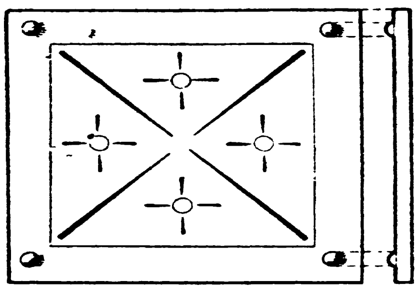
The time has now arrived for directing the pupil's attention to these terms. They need not cause any confusion in the scholar's mind, if properly explained to begin with. A suitable object with which to demonstrate would be an ordinary brick. Show brick to class, presenting a front view (front elevation), asking them to make a drawing of this. Now show class the end view (end elevation), and again ask scholars to make a drawing of this. Once again let brick be viewed from above and drawn. These three pictures or views represent the three dimensions, and are respectively the front elevation, the end elevation, and the plan.

Exercise 17. On this plate are shown some very simple objects illustrating other examples of plan, end view, and front view, and they should be handled before the class, and the scholars made thoroughly familiar with the meanings of these terms.

Later on the pupils might model these simple objects for themselves.

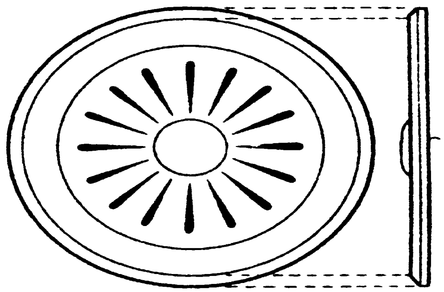
PLATE VIII

18. "Flat" Relief. Enlarge to twice size.



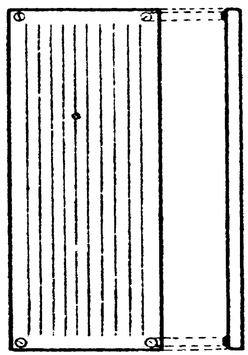
Tile, with four buttons at corners. Pattern scratched (incised).

19. "Flat" Relief. Enlarge to twice size.



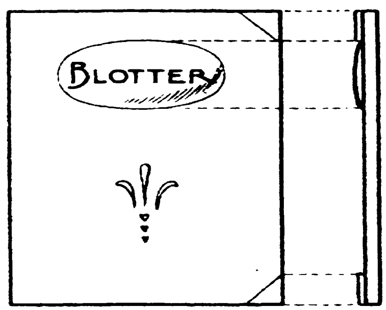
Coal-hole Plate—iron. Centre slightly raised. Star pattern scratched or "pierced".

20. "Flat" Relief. Enlarge twice.



Brass Finger Plate. Lines "scratched" or "incised"

21. "Flat" Relief. Enlarge twice.



Leather Blotting Case. Embossed and "tooled".

PLATE VIII

We now come to the making of thicker layers of clay, for the future designated slabs. The pupils should proceed in this way. First draw on millboard or modelling slate an outline of shape required. In the case of a square, place at each corner a piece of clay built up to the required thickness or relief, and then fill in, building up to a uniform level. Be careful to press firmly the added clay in order to produce one solid mass. Smooth over surface with edge of flat ruler, which may require wetting if the clay should stick, and finish off with thumb. Should the edge of slab need trimming, use point of tool.

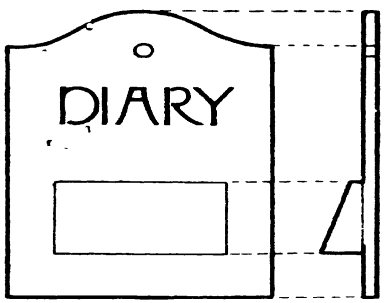
Exercise 18. At each corner of the slab place a button of clay. Observe the extra relief indicated in the side elevation. The incisions should be cut firmly, a ruler being used if necessary.

Exercise 19. Trace off circle by any mechanical means, using chalk outlines on ground. Build up circular slab as directed above; the thickness or relief is denoted by the side-view drawing. The centre is slightly raised; the star pattern is pierced, *i.e.* cut right away.

Exercise 20. The reeded finger plate will require to be grooved with the point (not the sharpest) of tool: a ruler may be wanted. The rounded heads of the screws are shown in the side view.

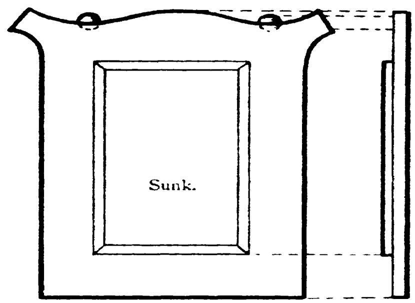
Exercise 21. Build up slab and boss up ellipse by adding pieces of clay, well pressing the same into slab beneath. Draw scholars' attention to the side view of boss as shown in the section.

22. "Flat" Relief. Enlarge twice.



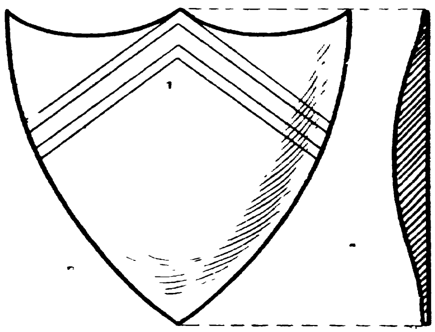
Cardboard Calendar. Incised title.

23. "Flat" Relief. Enlarge twice.



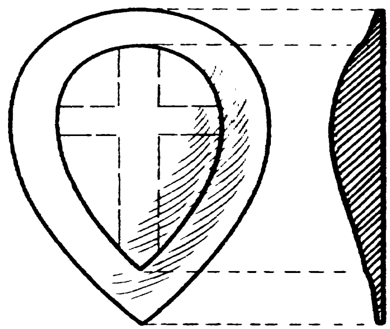
Wood Notice-board. Centre sunk slightly.

24. "Rounded" Relief. Enlarge twice.



Sunk Metal Shield. Pattern incised.

25. "Rounded" Relief. Enlarge twice.



Crusader Shield. Cross incised.

PLATE IX

Exercise 22. First build up slab according to plan[1]. On surface of clay outline the calendar, and within this build up another slab carefully observing its side view. The title is incised.

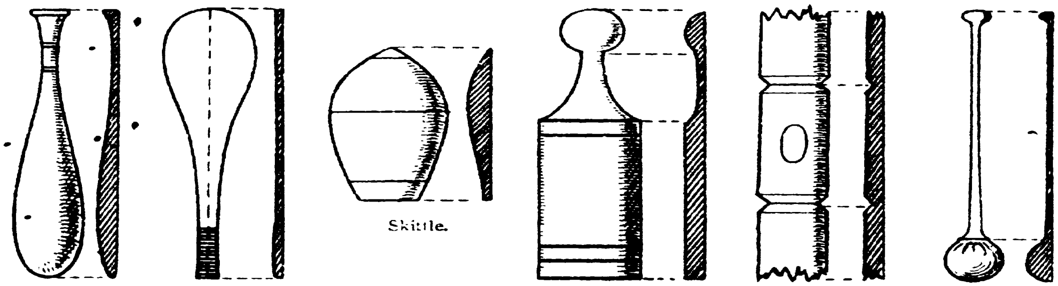
Exercise 23. Slab should first be made. Notice the raised moulding and slightly sunk ground within it.

Exercises 24 and 25. In these exercises we have examples of slightly rounded relief, the building up of which should proceed in this wise. If modelled on millboard, first draw outline of shields in chalk. Then build up a ridge of clay corresponding to the highest relief as shown in the sectional drawing; this will be in the middle of shield. After this build up on each side of this ridge, taking care to diminish relief as shown in section, and also observing to keep within the outline. An even and smooth surface will be obtained with the thumb.

A better effect is obtained by building the same upon a slab. This is done in precisely the same way, the only difference being the outline of shield is drawn upon the clay surface. A low relief is preferable, the result of which will give an appearance of unity with the ground.

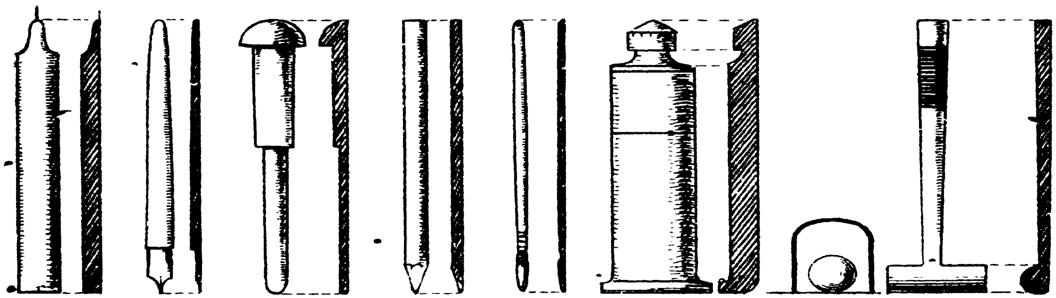
[1] This term is here and in other places applied to the "front elevation" of an object as drawn upon the bed of clay, in which case it is considered a "plan" on which the object is built up. (See Glossary.)

26. Very Low Relief—no clay background. Surface only very slightly rounded to suggest requisite curvature. Enlarge two or more times.



Club. Fives Bat. Skittle. Ninepin. Cracker. Drumstick.

27. Low Relief Examples continued. Enlarge two or more times.



Candle. Pen. Easel Peg. Pencil. Paint-brush. Tube of Colour. Croquet Mallet, &c.

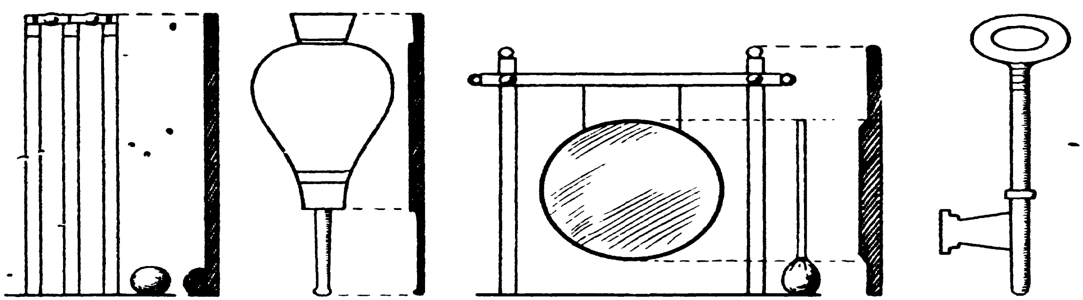
PLATES X AND XI

Exercises 26–29. Numerous examples on these plates are presented in order to meet the exigences of class teaching when it is not possible for each scholar to have a separate object. Before working the exercises here given it would be distinctly advisable to present to class a real sample of each object, and elicit from scholars the description of surface, whether round or flat, smooth or rough. Draw scholars' attention to the different thicknesses of sectional drawing, this latter being the *conventional* method adopted for showing the amount of relief sufficient for the representation of each object.

In order not to confuse the scholar it will be noticed that in all round objects *one sectional drawing, and this the side view, is alone shown, this being all that is really necessary.*

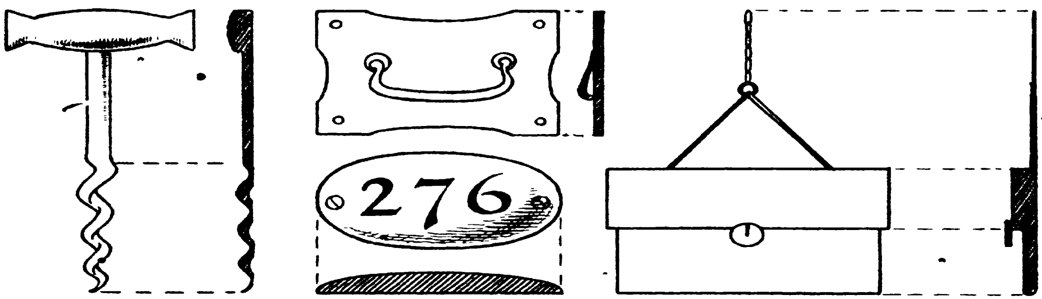
Many of these objects may be modelled in whole or free relief.

28. Low Relief Examples continued. Enlarge two or more times.



Wickets. Bellows. Gong. Key.

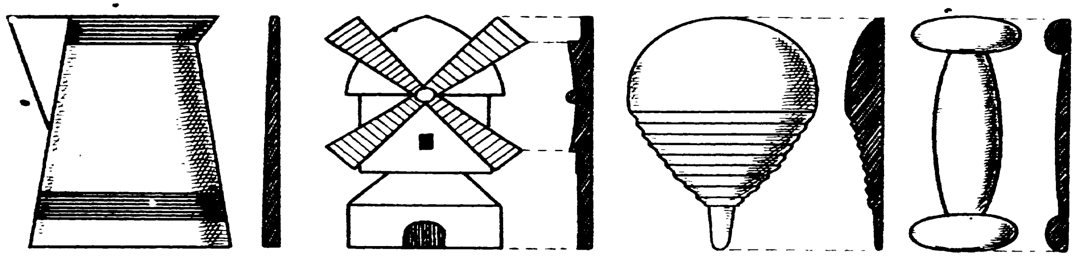
29. Low Relief Examples continued. Enlarge two or more times.



Corkscrew. Doorplate. Chatelaine Bag or Music Case.

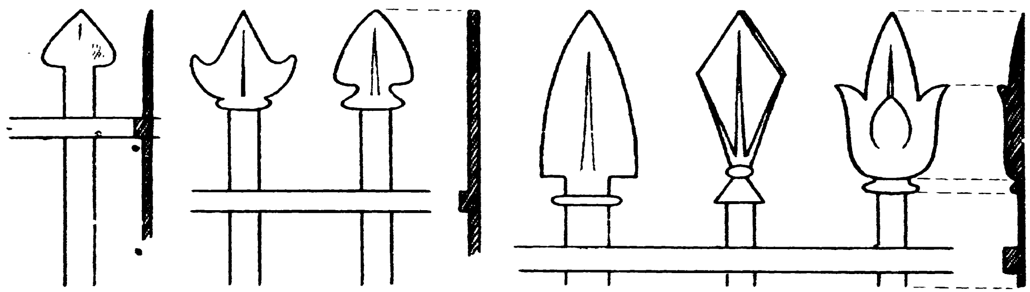
PLATE XII

30. Low Relief Examples continued. Enlarge two or more times.



Jug. Windmill (toy). Top. Dumb-bell.

31. Low Relief Examples continued—Railing Tops. Enlarge two or three times.



Various patterns.

PLATES XII AND XIII

Exercises 30–33. Most of the exercises given in these and preceding plates may be treated in three different ways, and would afford additional practice if worked as suggested.

1. The outline might be shaped on a thin layer of clay and the surrounding portions cut away, showing a flat relief.
2. Or, an outline may be drawn upon a thick slab of clay, and another thickness superimposed, showing either a flat or low rounded relief.
3. Or, the object may be modelled directly on the millboard, the outline of the plan having been drawn on ground.

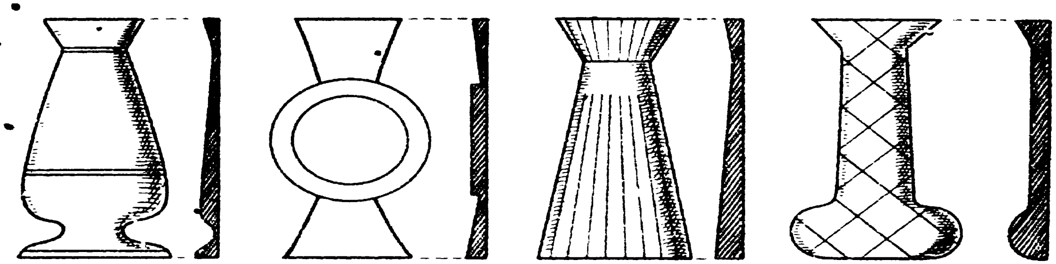
Exercise 30. Notice the raised section showing the superimposed sails of windmill. Outline on the underlying slab of clay the contour of sails, and build up to height required. The door of windmill is shown by cutting clay right away.

Exercise 31. Observe the relief of the top crossbar of railing heads.

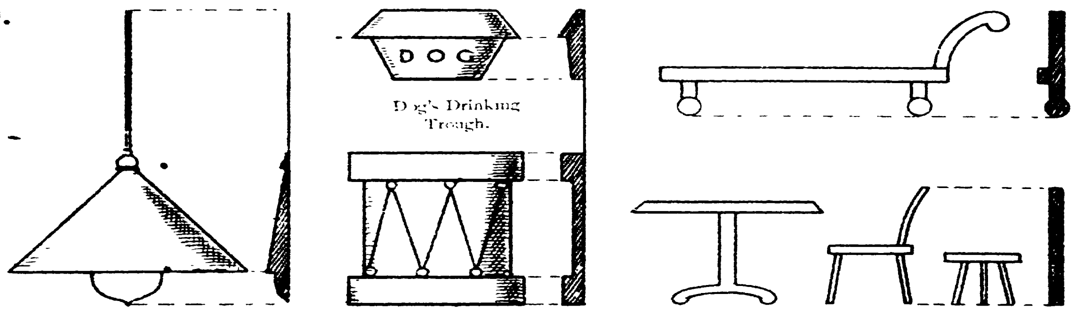
Exercise 32. These may be modelled in a variety of ways as suggested above. The second form of vase, however, should be modelled in fairly flat relief only. It is obvious that no ground plans are necessary for these round objects.

Exercise 33. The front or side view only of these dolls' toys will be modelled; the relief is shown. If cardboard "tops" to table, chair, sofa, and stool be employed, the objects then might well be modelled in whole relief rather than pictorially.

32. Low Relief Examples continued—Vase Forms. Enlarge two or more times.



33. Low Relief Examples continued—Miscellaneous. Enlarge two or more times.



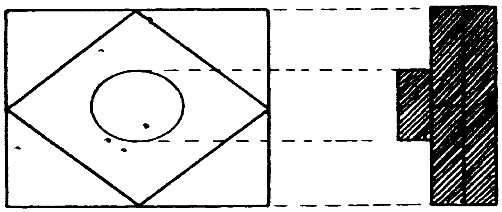
Electric Bulb.

Drum.

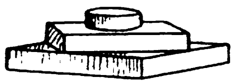
Profiles of Dolls' Sofa, Chair, Table, and Stool.

PLATE XIV

34. Make Slabs—certain sizes, shapes, and thicknesses—and superimpose as shown.

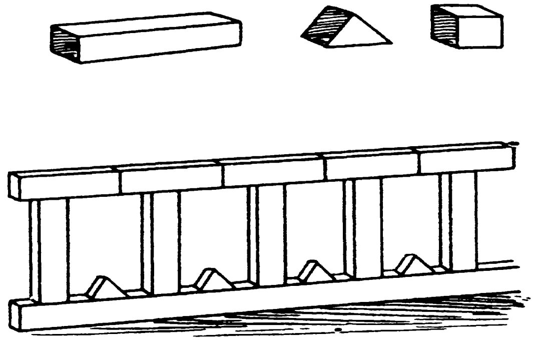


Top view. Side view.

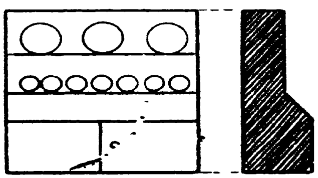


Pictorial view.

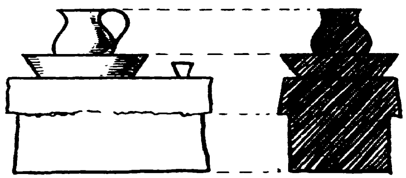
35. Make Bricks of all sizes and shapes from toy bricks, and build with them.



36. From Slab and Brick forms make various Dolls' Toys.



Dresser.



Wash Table.

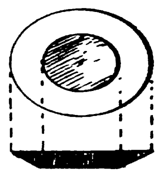
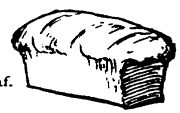
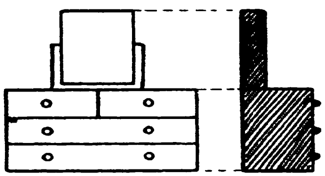


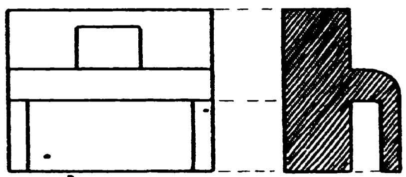
Plate.



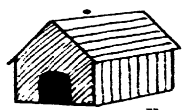
Loaf.



Looking-glass.



Piano.



Kennel.

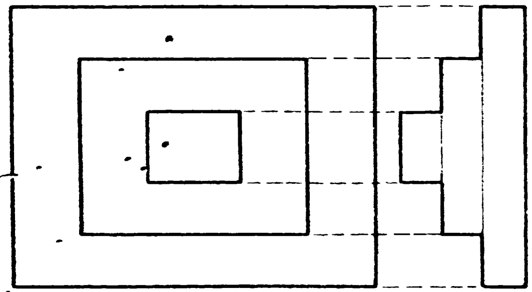
PLATE XIV

Exercise 34. This is a further example of slab treatment.

Exercise 35. An exercise in brick modelling and building. Pupils will observe that bricks are, after all, slabs of special dimensions. Bricks could also be ***moulded*** by mechanical means.

Exercise 36. These are simple renderings in block forms of toy objects. The shaded sectional drawings merely indicate thickness. These will be more clearly understood by the scholars if the teacher first models some larger-sized representation, so that pupils may clearly discern the front and side views.

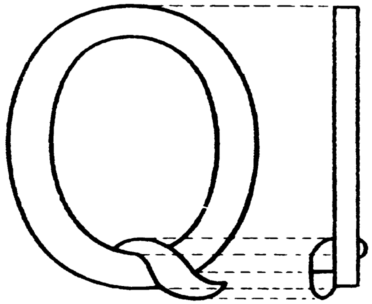
37. "High" Relief. Enlarge twice.



Side view or Thickness.

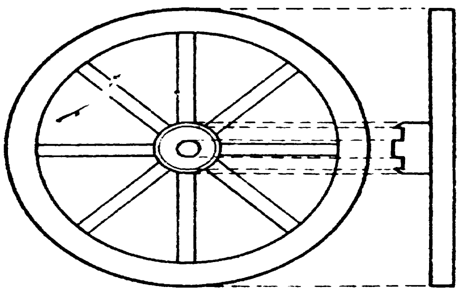
Pyramid of "Slabs".

38. "High" Relief. Enlarge twice.



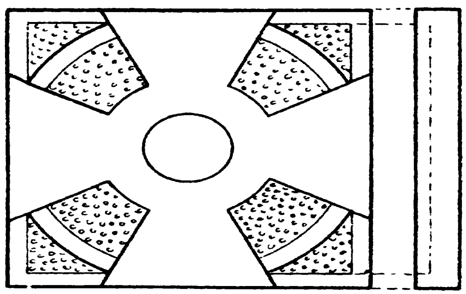
Block Letters of the Alphabet. Side.

39. "High" Relief. Enlarge twice.



Cart Wheel. Lying flat on its back.

40. "Low" Relief. Enlarge twice.



Stone Cross (Maltese). Ground "dotted".

PLATE XV

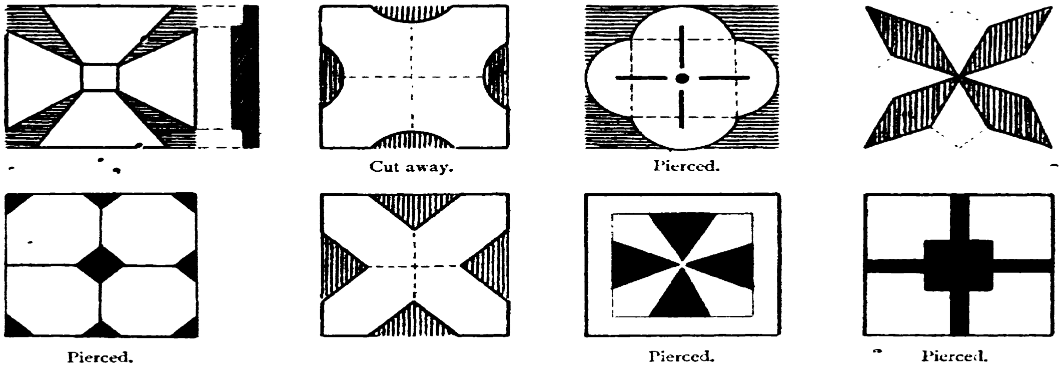
Exercise 37. Other shaped slabs could follow this example.

Exercise 38. Simple letters and numerals could be treated similarly, being careful to obtain an even thickness all through and a perfectly flat face.

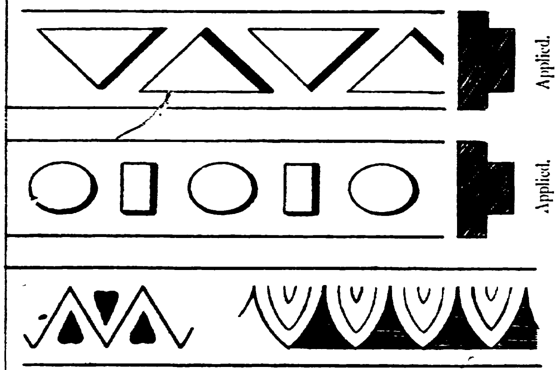
Exercise 39. Circle and spokes drawn in chalk. Rim of wheel will be in somewhat higher relief than spokes; axle considerably higher. Hinder portion of axle is necessarily omitted in the modelling.

Exercise 40. Preferably done on slab: outline incised: ground slightly cut away with tool, and spotted with the point.

41. Slabs—ornamentally cut away and pierced. Enlarge two or three times.

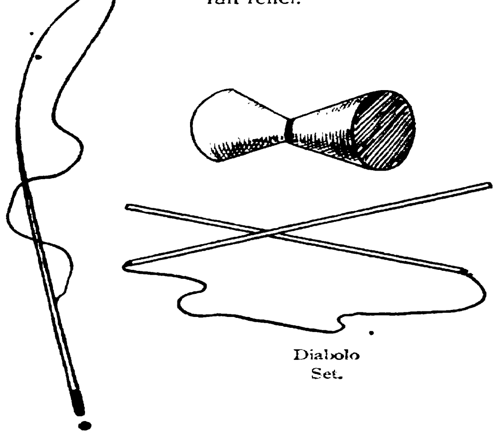


42. Borders with Slabs applied or Piercings. Enlarge.



Pierced. Pierced.

43. Simple Objects (from real specimens) in full relief.



Whip.

PLATE XVI

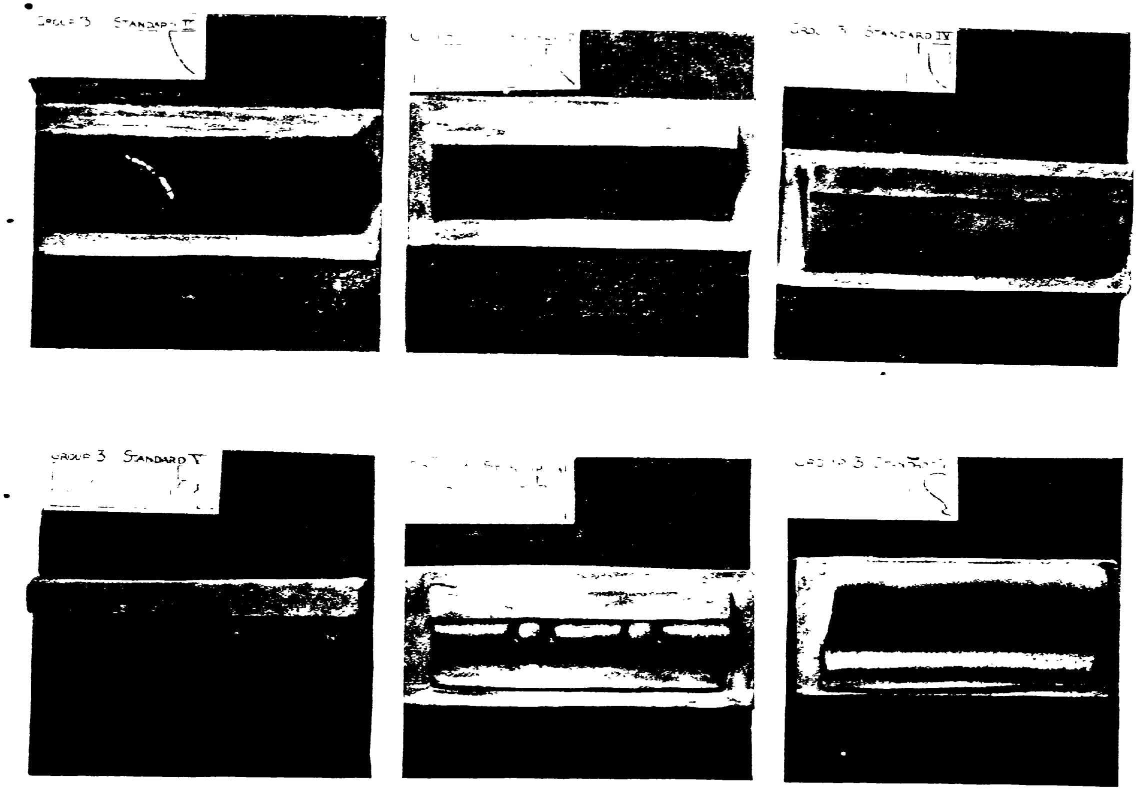
Exercise 41. Slabs are first carefully made as in note on Plate VIII. The figures are then drawn, and the shaded portions are cut either wholly or partially away. Three examples, where darkly shaded, have holes pierced completely through.

Exercise 42. Examples of applied slab, incised, and pierced work.

Exercise 43. Modelling in the round in full relief from an actual object.

SERIES OF MOULDINGS

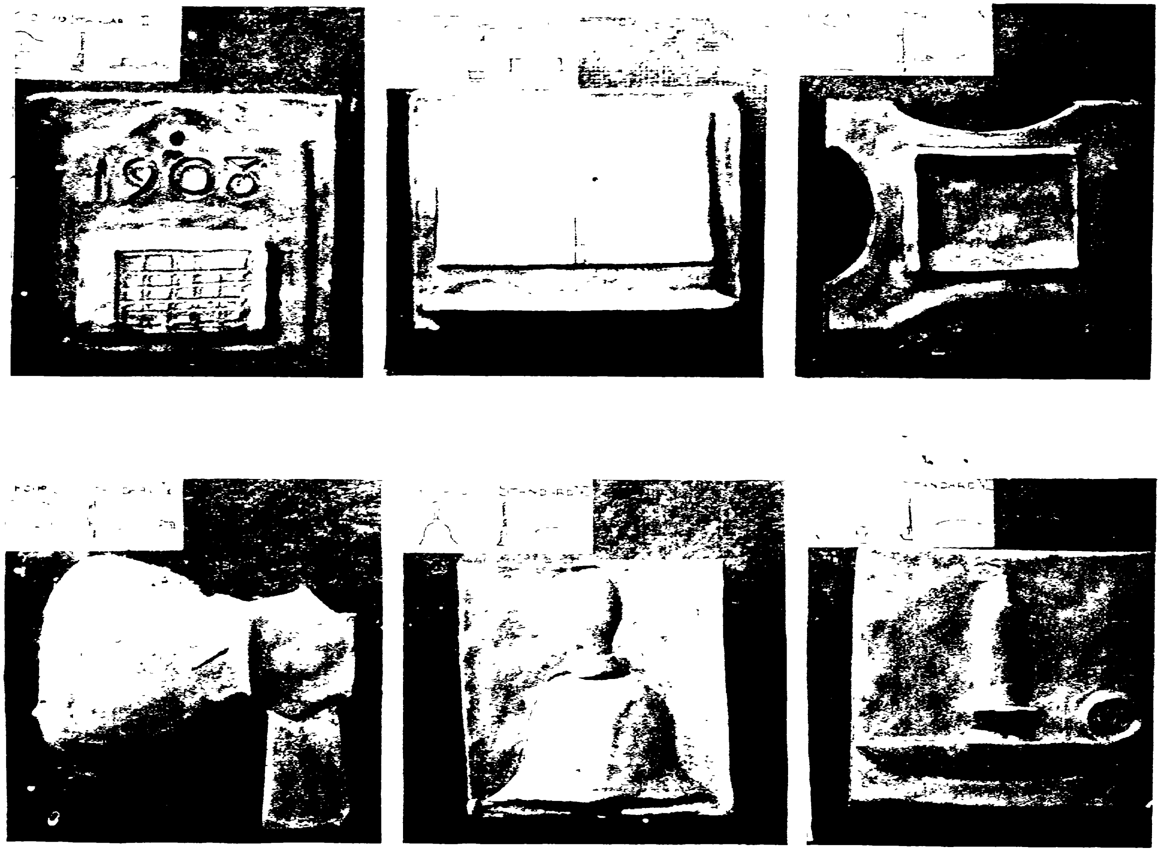
To be enlarged two, three, or four times



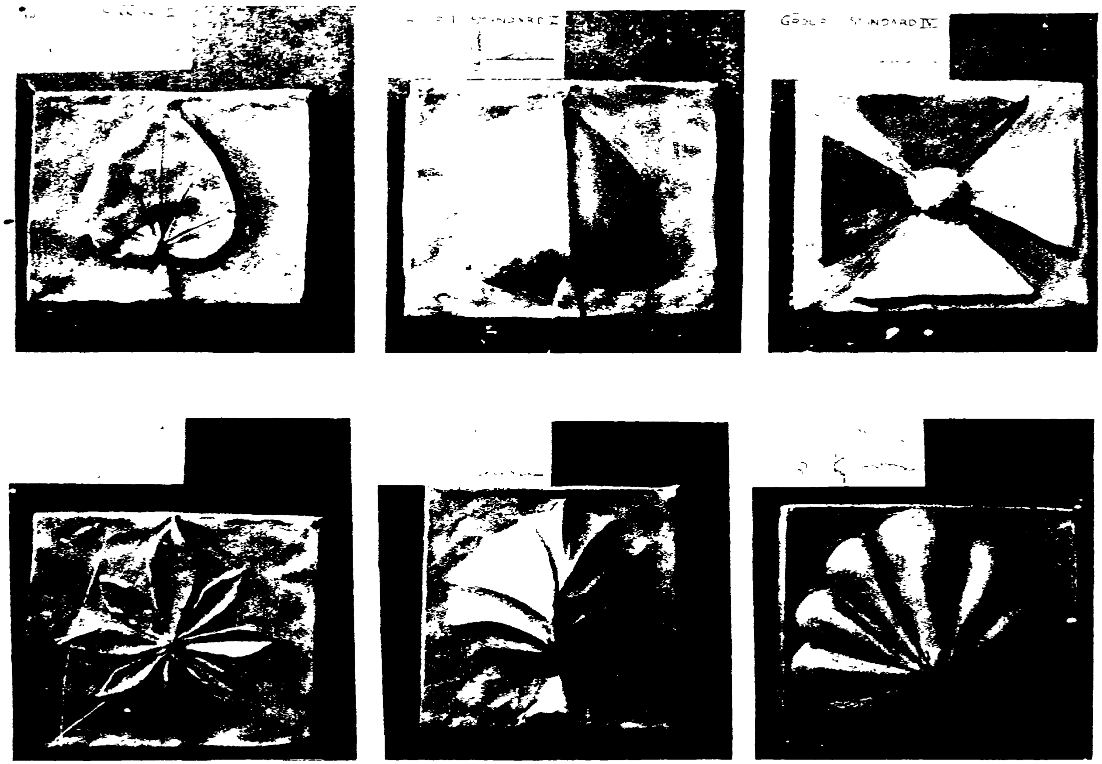
The photographs here reproduced are taken from specimens worked by scholars from drawings as shown in the corner. Modelling from these photographs will afford excellent practice. As an additional exercise they might be drawn with the pencil.

SERIES OF COMMON OBJECTS

To be enlarged two, three, or four times



SERIES OF CONVENTIONAL FORMS



SERIES OF ROSETTES

To be enlarged two, three, or four times

Rosettes have a special value for modelling purposes, and are capable of infinite variety in design and relief. It is obvious that these rosettes when modelled afford excellent examples from which to shade.

INTERMEDIATE COURSE

Leaves or other Natural Forms—first modelled realistically from nature, then arranged conventionally and treated in the flat.

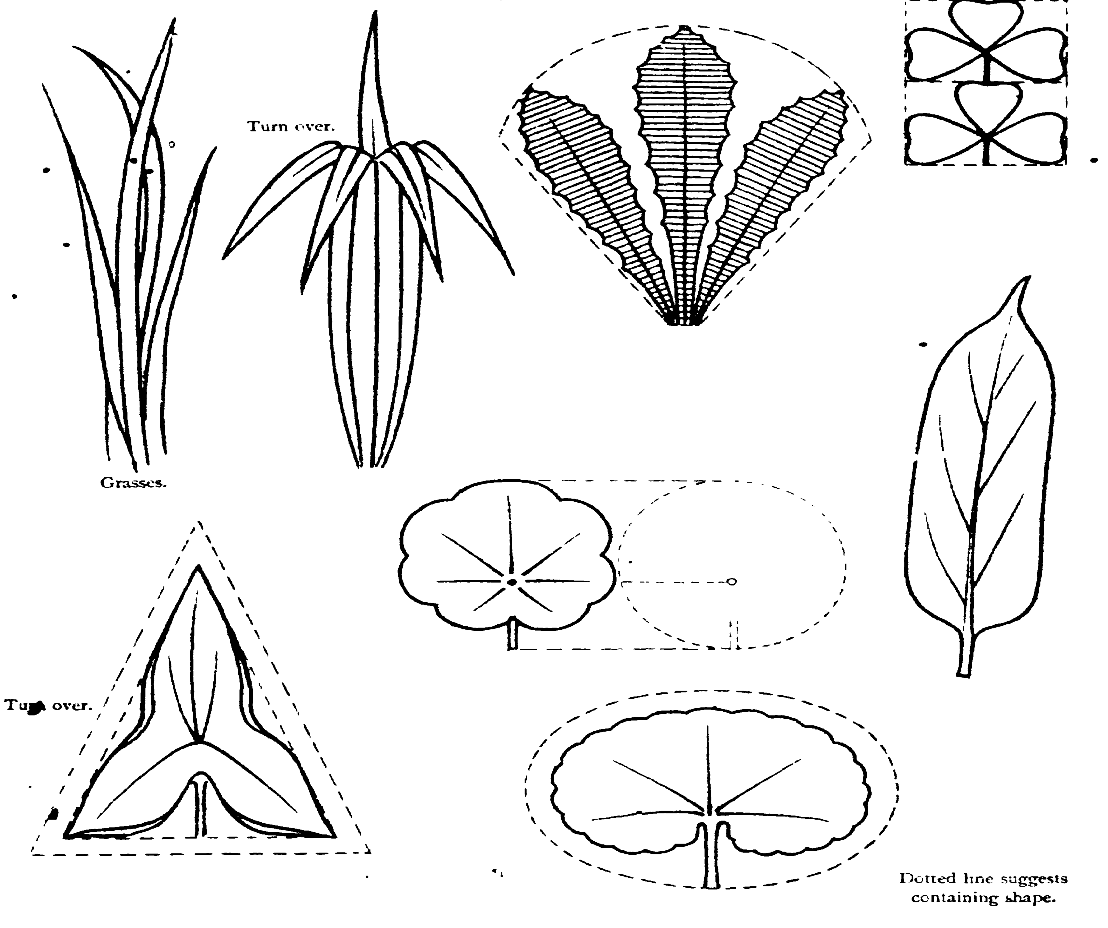


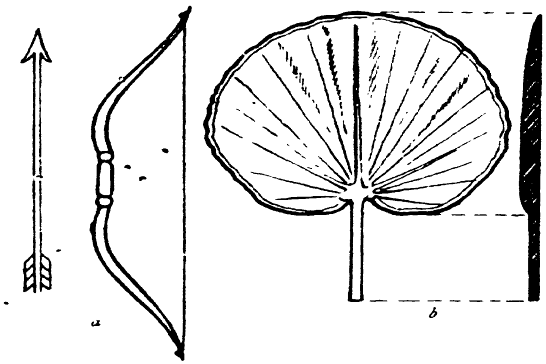
PLATE XVII

These are examples of leaf forms treated conventionally and in the flat, from the decorative point of view.

At this stage they may either be shown as incisions on thin layers of clay, or by cutting away the surrounding clay may show very slight relief, or they may be built up in very low and flat relief upon an underlying slab of clay.

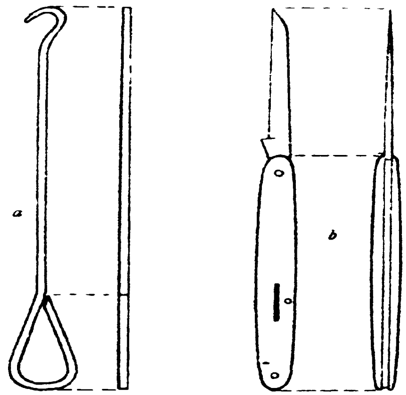
If used for decorative purposes as units in design they would be applied to borders, panels, &c., as shown in Exercise 42.

44. "Low" Relief in the round. Enlarge twice.



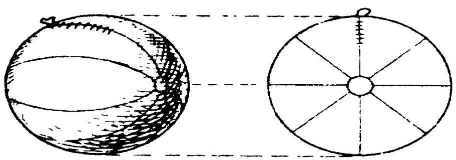
a, Bow and Arrow, lying flat. *b*, Palm Fan, lying flat.

45. "Low" Relief in the round. Enlarge twice.



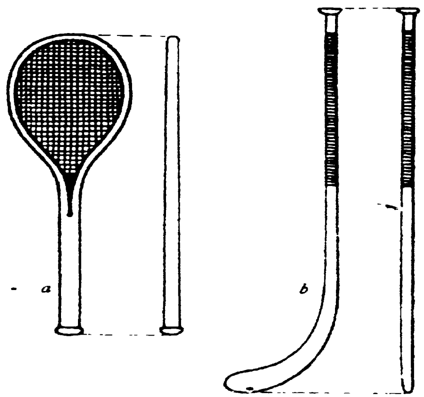
a, Button Hook; *b*, Penknife, both lying flat.

46. "Round" Relief. Enlarge three times.



Football. Modelled "round" and resting on ground.

47. "Low" Relief in the round. Enlarge twice.



a, Tennis Racket; *b*, Hockey Stick, both lying flat.

PLATE XVIII

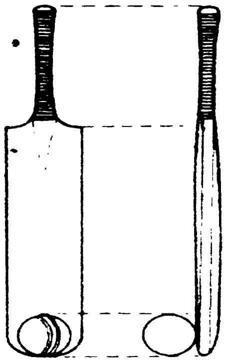
Exercise 44. Modelled in low relief in the round. As an additional exercise the fan could be incised on square slab.

Exercise 45. Note that one long strip or roll of clay is required for button hook. To obtain an even roll, it should be rolled on board.

Exercise 46. The ball stands in the round, *i.e.* absolutely free. Mass of clay should be rolled in hand and incised.

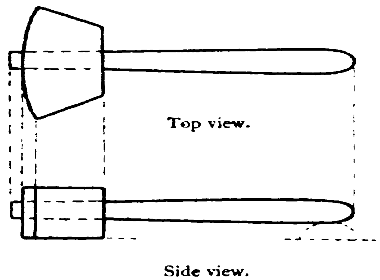
Exercise 47. Racquet strings to be shown by incisions, or by actual string or cotton.

48. "Low" Relief (ball "round"). Enlarge twice.



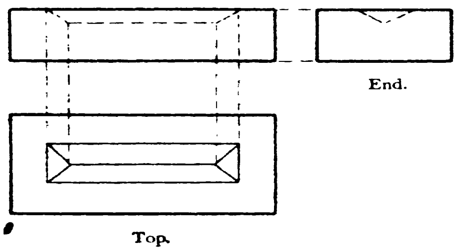
Bat and Ball, lying on ground or standing against wall.

49. "Whole" Relief. Enlarge twice.



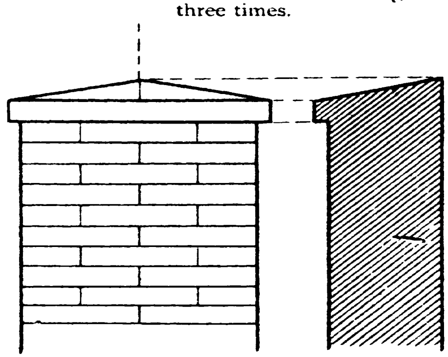
Mallet. Lying on its side on ground.

50. "Round" Relief. Enlarge two or three times.



Brick. Resting on one face.

51. "Round" or "Half" Relief. Enlarge two or three times.



Gatepost (square). Section equals half elevation.

PLATE XIX

Exercise 48. Handle, splice, and seam of ball carefully incised. Note that bat is not standing on its end, but is supposed to be lying on the board. This applies to all similar instances of common objects.

Exercise 49. The mallet should be completely modelled, and is shown in drawing perfectly horizontal, the handle resting on a small piece of clay.

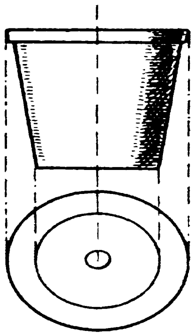
Exercise 50. Note the wedge-like sinking in top of brick scooped out by tool. The proportions of the three dimensions should be very carefully observed.

Exercise 51. This pier is not built up of separate bricks (though this might be done at a later stage), but is a simple rectangular prism crowned by a short pyramid. Brick joints incised with knife.

Note in this, and all future **round** relief drawings, that the half section (shaded in this case) corresponds to the half elevation (right or left of middle chain-dotted line), and that therefore if the object be required only in **half** relief, half of it need only be modelled away from the ground to the height of the half section. Hence **projection** amounts to distance right or left outwards from middle line. Wherever, then, a drawing shows a dotted chain line it means that the half, one way or the other, can be taken as the projection for a half relief. The relief will be square except where shading occurs, which indicates (unless sufficiently self-evident) that the object is a round one.

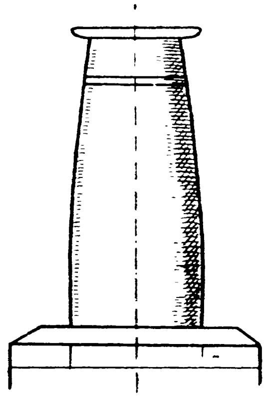
N.B.—The amount of clay or plasticine given to each scholar will in all probability not permit of half relief always being shown. In this case the pupil will build up to quarter or lower relief as directed.

52. "Round" Relief. Enlarge two or three times.



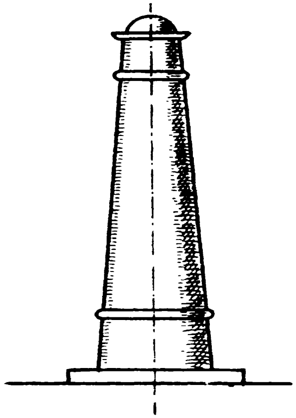
Flowerpot. Standing.

53. "Round" or "Half" Relief. Enlarge twice.



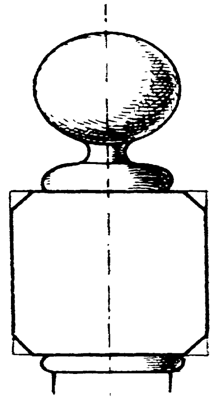
Chimneypot. Standing, or in half relief.

54. "Round" or "Half" Relief. Enlarge twice.



Street "Refuge" Post (iron). Standing, or in half relief.

55. "Round" or "Half" Relief. Enlarge twice.



Top of "Newel" Post (wood). "Half" Relief.

PLATE XX

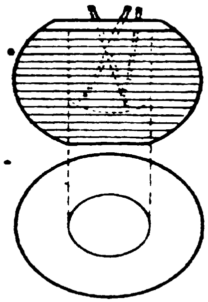
Exercise 52. It is advised this simple object be modelled in the round, starting with round base. Care and patience will be wanted in building up sides of pot to obtain a true circle. Add rim last.

Exercise 53. Chimney may be modelled solid, stack of bricks square.

Exercise 54. Circular street refuge post, practically cannon with cannon-ball in mouth, and standing on square slab.

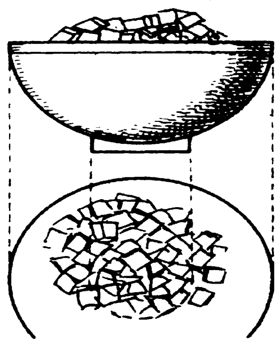
Exercise 55. Top of banister post modelled in the round or half relief.

56. "Round" Relief. Enlarge two or three times.



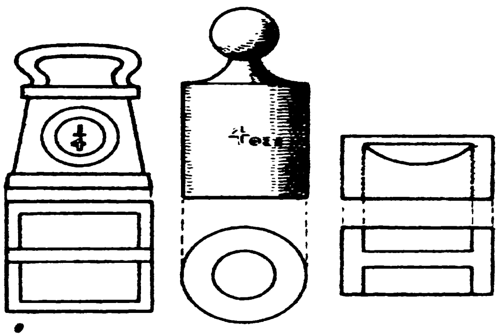
Glass or China Match Holder. Standing.

57. "Round" Relief. Enlarge two or three times.



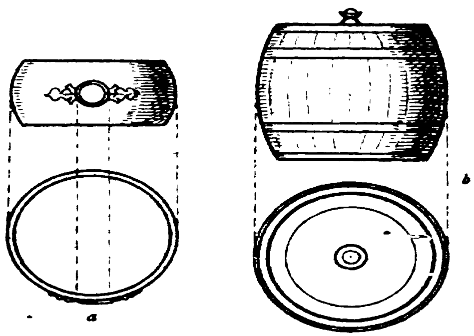
Sugar Basin. Standing.

58. "Round" Relief. Enlarge each twice.



Iron and Brass Weights. Standing.

59. "Round" Relief. Enlarge two or three times.



a, Serviette Ring (ivory); *b*, Biscuit Box, both standing.

PLATE XXI

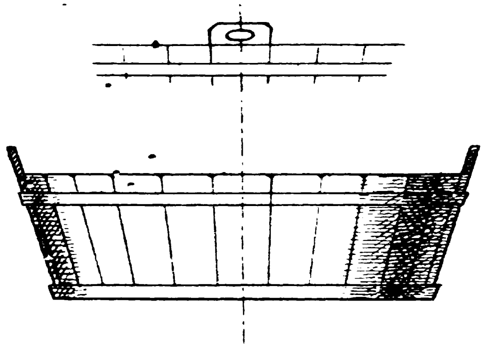
Exercise 56. Practically a flattened globe, centre scooped out, and lines on outer surface incised. Matches could be modelled.

Exercise 57. No necessity to show the hollow of basin. Model cube lumps of sugar. Exercise to be done in the round.

Exercise 58. These weights to be made in the round.

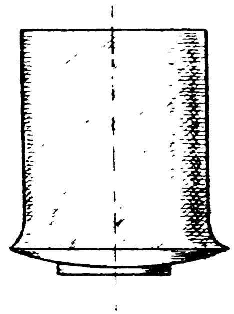
Exercise 59. Note that serviette ring is thickness only and is not solid. The bands around biscuit box might be strips of clay, other lines incised: biscuit box is however solid.

60. "Round" or "Half" Relief. Enlarge twice.



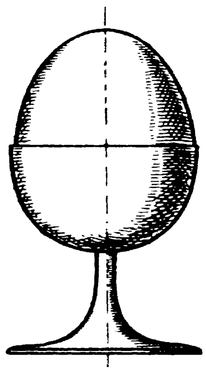
Washing Tub. Standing, or in half relief.

61. "Round" or "Half" Relief. Enlarge twice.



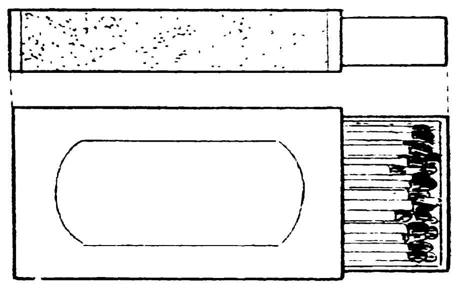
Glazed Vase. Standing, or in half relief.

62. "Round" or "Half" Relief. Enlarge once and a half.



Egg and Egg Cup. Standing, or in half relief.

63. "Round" Relief. Same size.



Matchbox. Resting on one face.

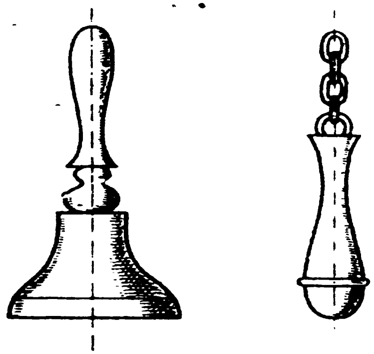
PLATE XXII

Exercise 60. Can be done in whole, half, or quarter relief. Sides of tub modelled rather thickly. Observe handle.

Exercises 61 and 62. Modelled in round, half, or quarter relief.

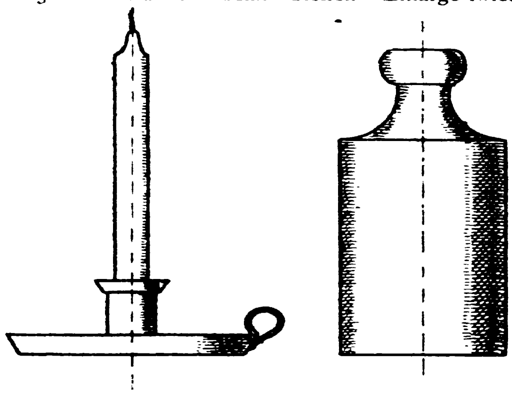
Exercise 63. Note that the box is merely a thickened slab, on which is built up a smaller one. Only slightly scoop out inside of box on which to lay matches, as much of them as is visible.

64. "Round" or "Half" Relief. Enlarge two or three times.



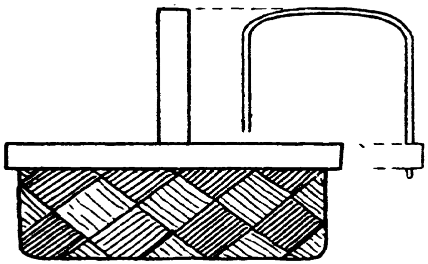
Bell and Bell-pull. In full or half relief.

65. "Round" or "Half" Relief. Enlarge twice.



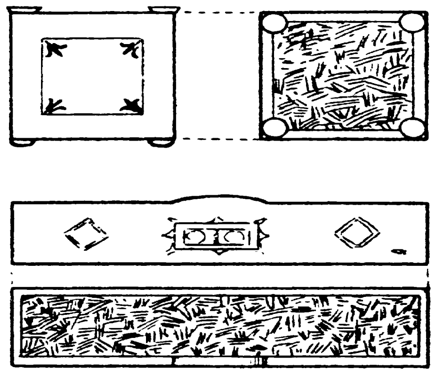
Candlestick and Stone Bottle. In full or half relief.

66. "Round" Relief. Enlarge two or three times.



Market Basket. Standing.

67. "Round" Relief. Enlarge twice.



Tile Window Boxes. Full relief.

PLATE XXIII

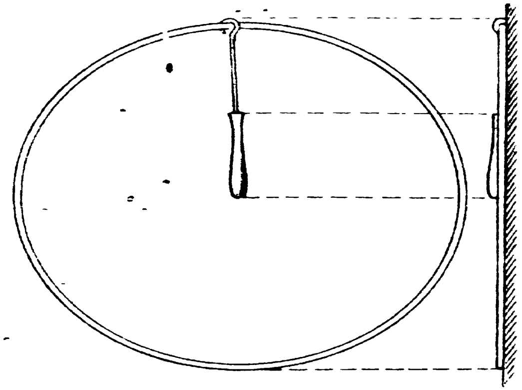
Exercise 64. Be careful to get handle vertical.

Exercise 65. Sufficiently obvious.

Exercise 66. Rectangular basket. Incise markings on sides according to pattern.

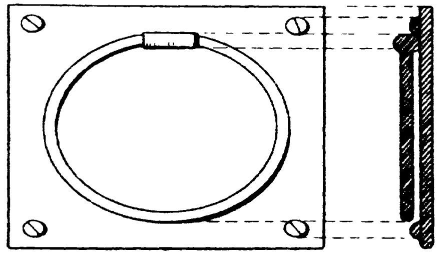
Exercise 67. The square box is a solid cube. Vertical faces can be gauged by holding ruler in vertical position, or by any other mechanical means.

68. "Low" Relief. Enlarge twice.



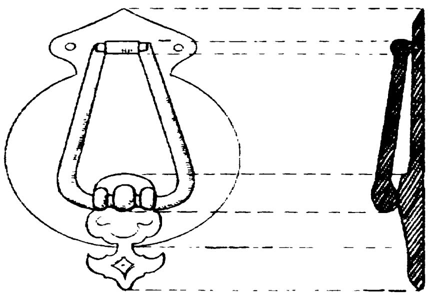
Hoop and Stick (iron). Resting flat.

69. "Low" Relief. Enlarge twice.



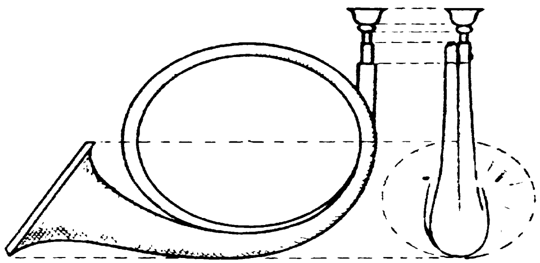
Metal Drawer Handle.

70. "High" Relief. Enlarge twice.



Metal Door Knocker.

71. "Round" Relief. Enlarge twice.



Brass Trumpet. Lying flat on side.

PLATE XXIV

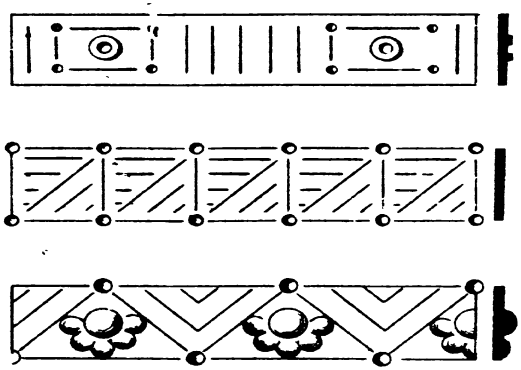
Exercise 68. Hoop is merely a thin solid roll of clay resting flat on millboard. Handle modelled separately and attached.

Exercise 69. Thin circular roll of clay placed on flat disc. The hinge is a small cylinder. Slab to be ornamented by slight finger or tool depressions. Projecting screws at corners.

Exercise 70. First model disc very thinly. Then outline handle with point of tool, and build up as required.

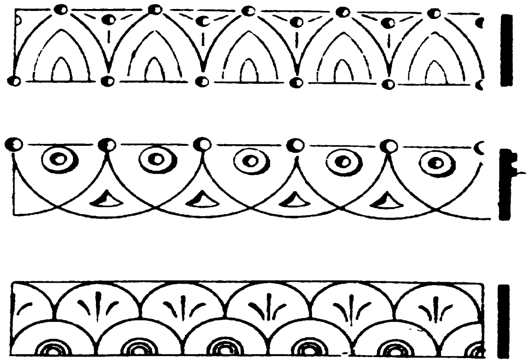
Exercise 71. Obtain a long roll gradually thickening the clay to one end Twist it into required shape. Add rim and mouthpiece separately.

72. "Incised." Enlarge two or more times.



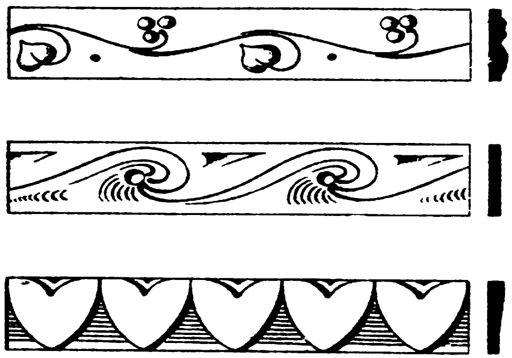
Straight lines, points, and "buttons".

73. "Incised." Enlarge two or more times.



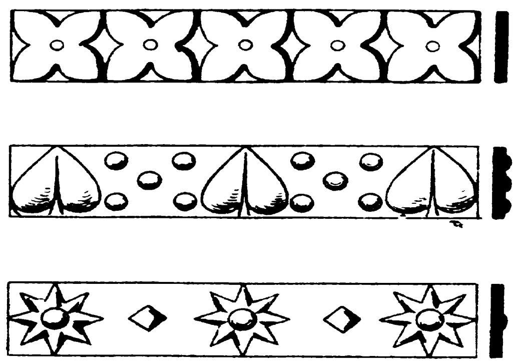
Curved Incisions.

74. "Flat" Relief. Enlarge two or more times.



Flat Ornament and Incisions.

75. "Low" Relief. Enlarge two or more times.



Low Relief Ornaments (applied).

PLATE XXV

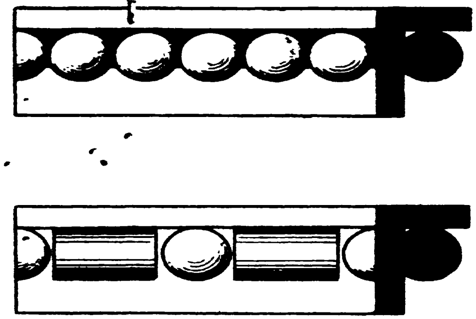
Exercises 72 and 73. These are merely incisions on slabs. They could be turned to form frames.

In all these and future ornamental diagrams it must be understood that the light is represented as coming from the left, when it will be easily perceived which are hollows and which raised portions. Obviously concavities will show shadows on the left side, and convex surfaces on the right.

In these particular exercises some pellets and buttons are shown.

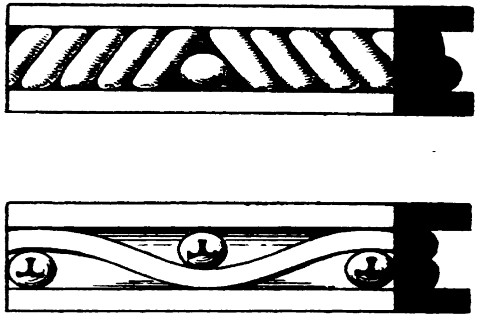
Exercises 74 and 75. In these borders each raised unit should be separately modelled and attached.

76. "High" Relief. Enlarge two or more times.



"Bead" and "Bead and Reel" Mouldings.

77. "High" Relief. Enlarge two or more times.

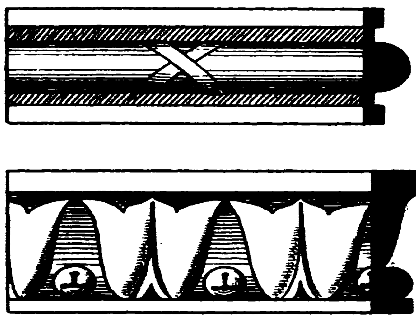


Note Sections.

78. "High" Relief. Enlarge two or more times.

(*a*)

(*b*)



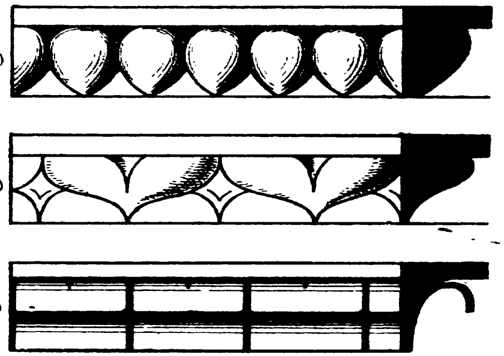
a, "Reed" Moulding. *b*, Cyma Recta.

79. "High" Relief. Enlarge two or more times.

(*a*)

(*b*)

(*c*)

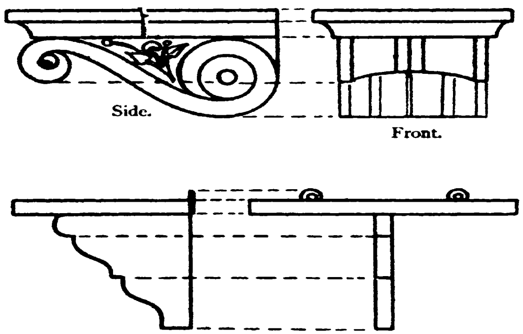


a, Ovolo. *b*, Cyma Reversa. *c*, Cavetto.

PLATE XXVI

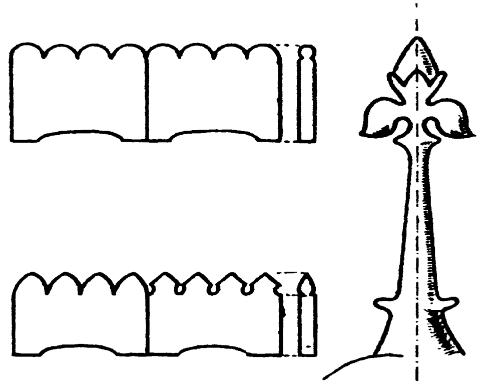
Exercises 76–79. A series of common mouldings as named (see Glossary). In every case model first the moulding simply, and add modelled ornaments, or incise or cut away as case may be, for example 77A and 79C.

80. "Round" Relief. Enlarge two or more times.



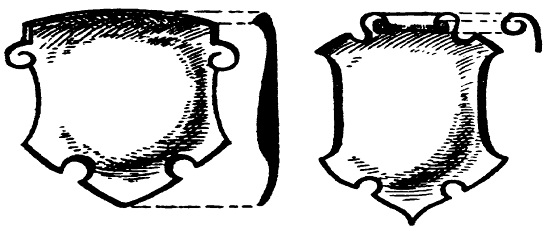
a, Stone Bracket. *b*, Wood Bracket.

81. "Round" Relief. Enlarge two or more times.



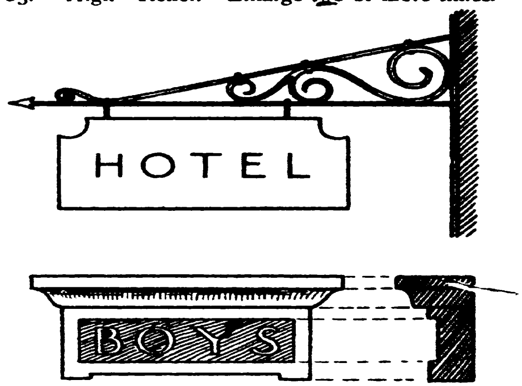
a, Terra Cotta Garden Edge Tiles. *b*, Gable Finial.

82. "High" Relief. Enlarge two or more times.



Silver or Wood Trophy Shields.

83. "High" Relief. Enlarge two or more times.



a, Iron Swing Board. *b*, Stone Panel.

PLATE XXVII

Exercise 80. This (80A) will be more easily shown in side elevation half or quarter relief only.

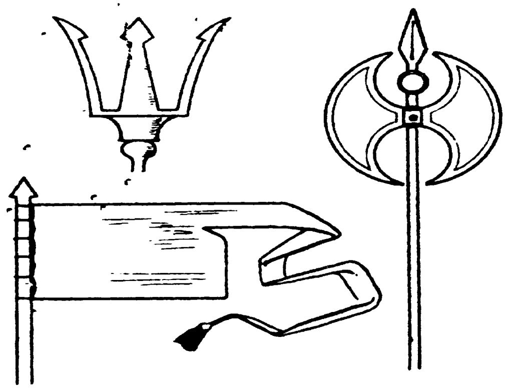
In 80P the exercise would be more satisfactorily carried out if the shelf were made of cardboard or wood and thinly covered with clay.

Exercise 81. Model slabs into shape of tiles, and repeat uniformly to make small garden border.

Exercise 82. Note the scroll at top of 82B. Central surfaces of shields are rounded, edges slightly concave.

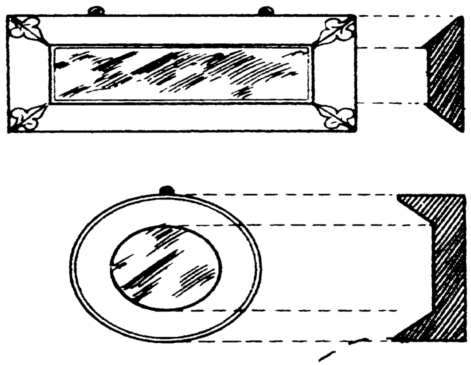
Exercise 83. These tablets are done in the flat.

84. "Low" Relief. Enlarge several times.



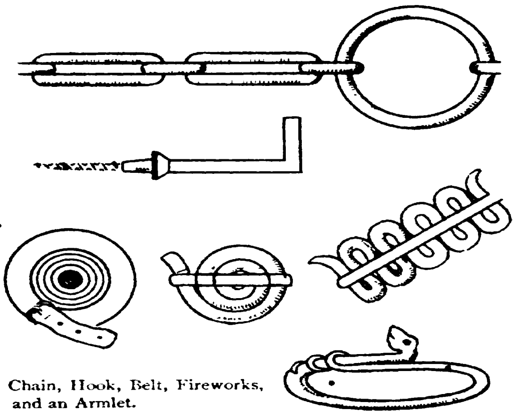
Emblems—Trident, Halberd, Pennon.

85. "High" Relief. Enlarge three times.



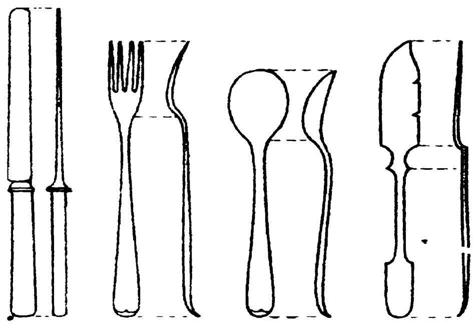
Wood Photo Frames.

86. "Low" Relief. Enlarge slightly.



Chain, Hook, Belt, Fireworks, and an Armlet.
Lying flat on ground.

87. "Half" Relief. Enlarge two or three times.



Knife, Fork, Spoon, Butter Knife.

PLATE XXVIII

Exercise 84. These are worked in the flat. Thickness to vary from one-eighth to one-quarter of an inch.

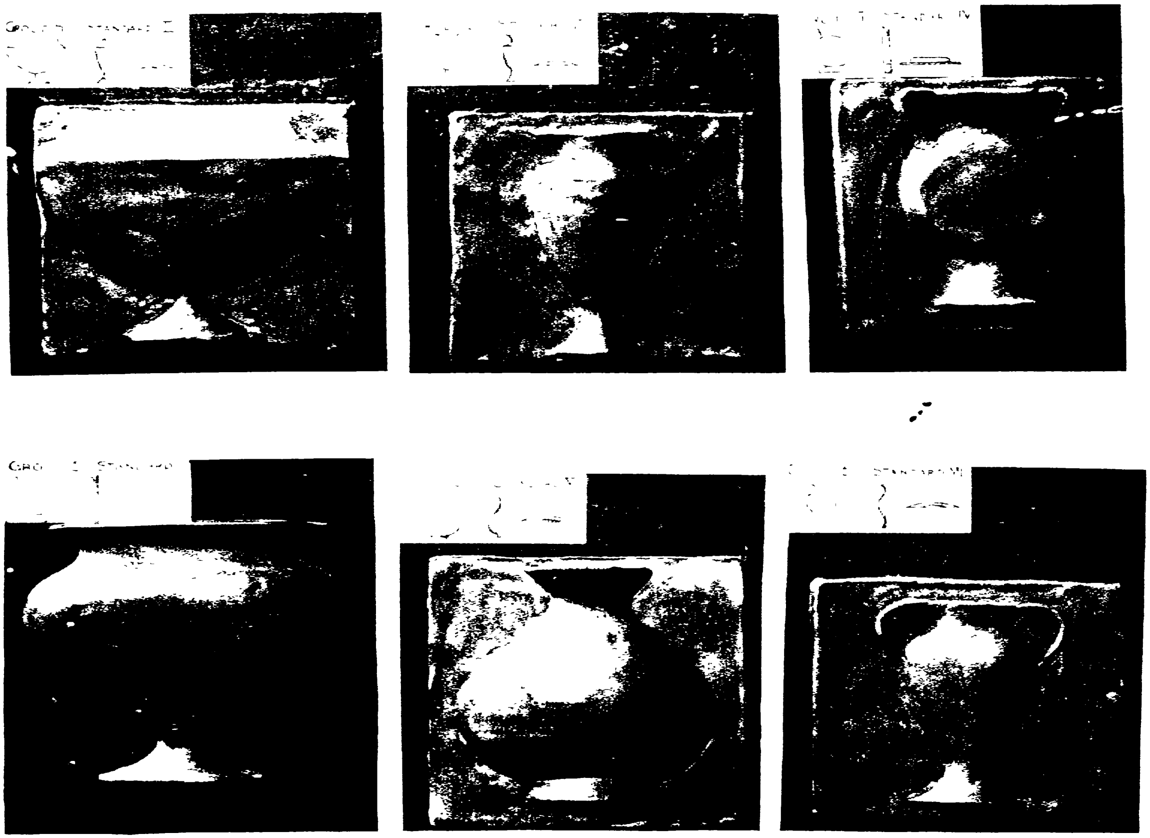
Exercise 85. Note carefully the sections of these. If a piece of tin-foil be inserted where glass would come the effect will suggest a mirror.

Exercise 86. Miscellaneous articles in very simple free relief, lying flat.

Exercise 87. These common objects to be modelled separately and lying on ground.

SERIES OF VASE FORMS

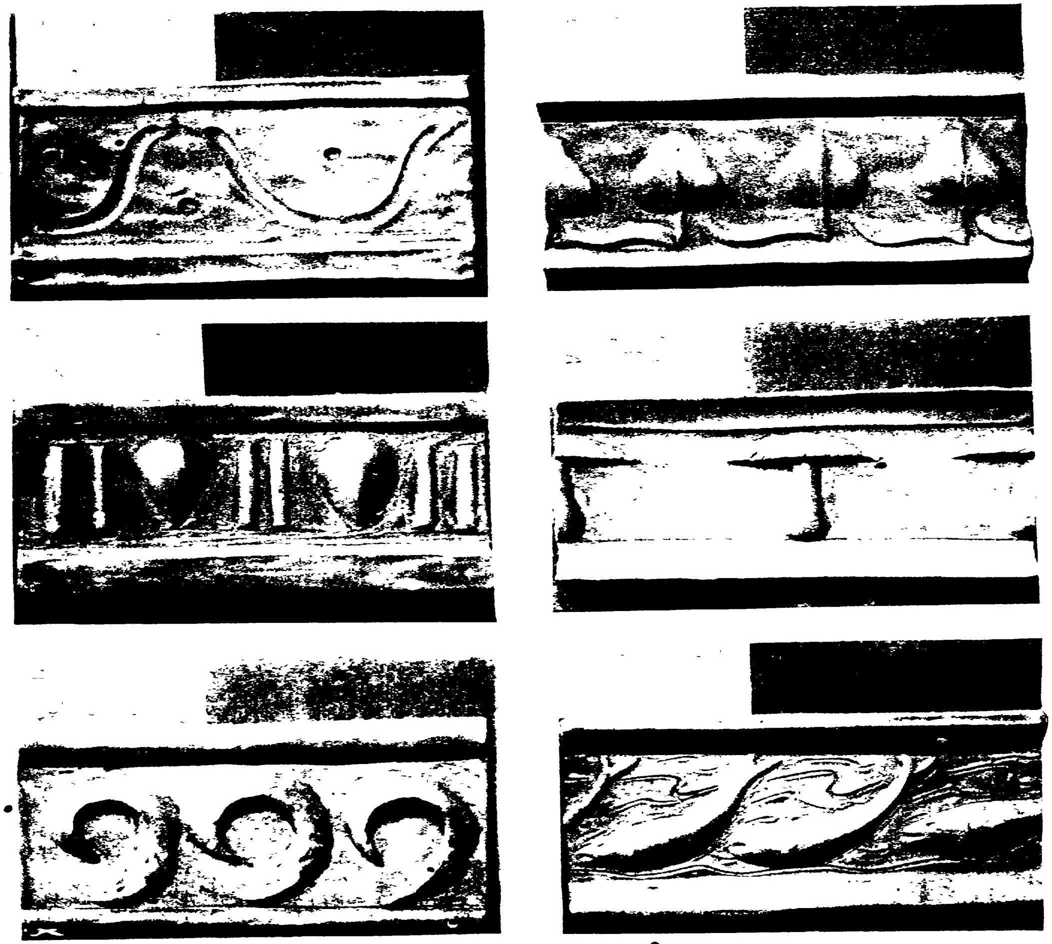
To be enlarged two, three or four times



The photographs here reproduced are taken from specimens selected by students, some of them from drawings, others from actual objects. As already suggested, these photographs may be used as copies either for modeling or for drawing with the pencil.

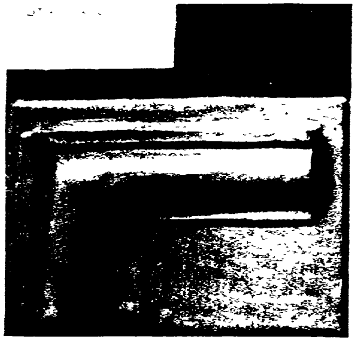
SERIES OF BORDERS

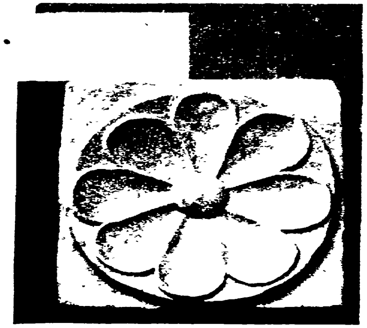
To [illegible] two, three, or [illegible] times

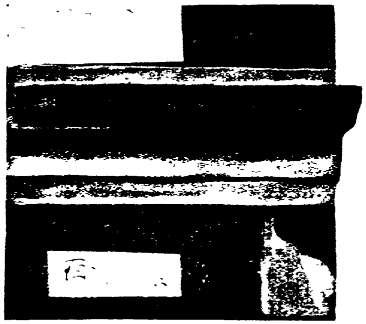


SERIES MISCELLANEOUS

To be enlarged two times, or four times

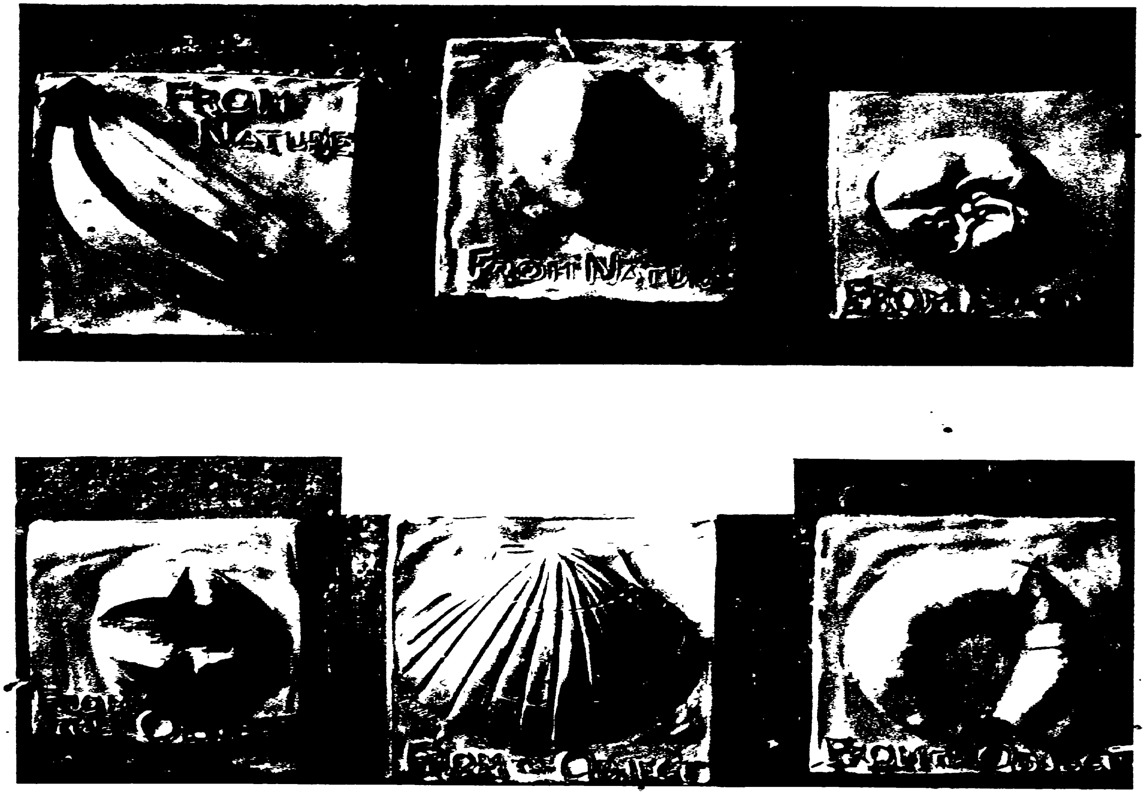






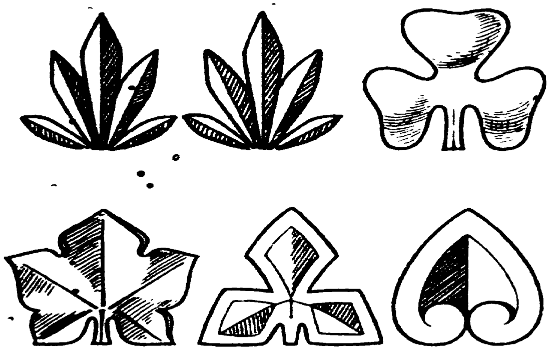
SERIES OF NATURAL FORMS AND COMMON OBJECTS

To be enlarged two, three, or four times



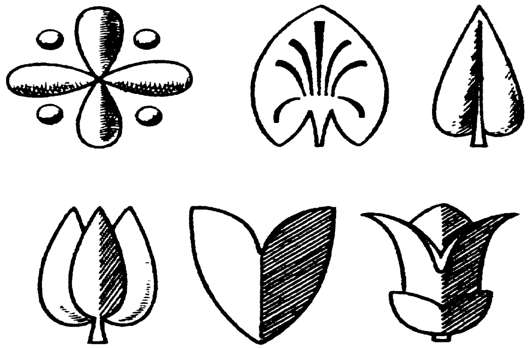
SENIOR COURSE

88. "Low" Relief. Enlarge two or more times.



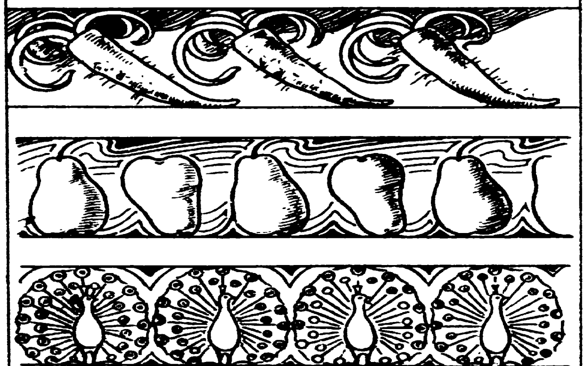
Ornamental Elements or Units.

89. "Low" Relief. Enlarge two or more times.



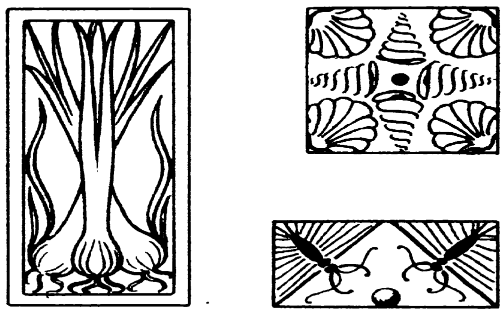
Ornamental Elements, singly or repeated.

90. "Middle" Relief. Enlarge two or more times.



Borders of—Carrots, Pears, Peacocks.

91. "Low" Relief. Enlarge two or more times.



Panels of—Leeks, Shells, Insects.

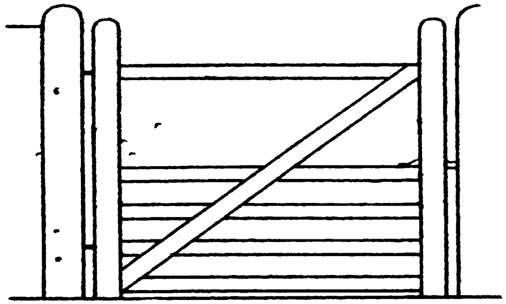
PLATE XXIX

Exercises 88 and 89. Some ornamental elements which can be used either individually or in clusters to form patterns. If used individually they should be many times enlarged. In the diagrams the light is supposed to come from the left.

Exercises 90 and 91. Borders and panels with simple naturalistic elements in slight relief. Enlarge several times.

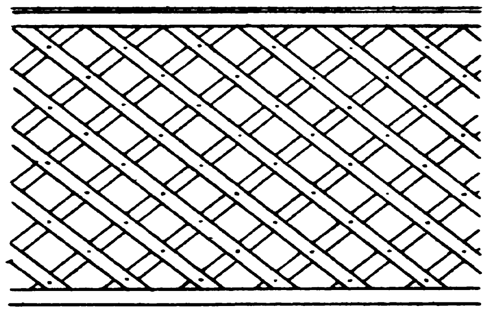
PLATE XXX

92. "Low" Relief. Enlarge twice.



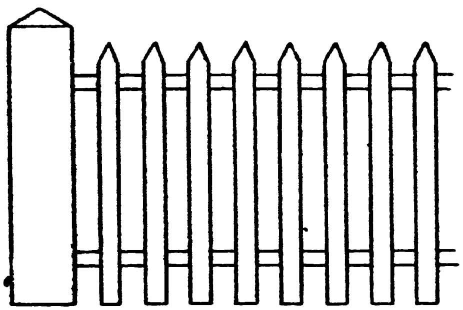
Gate (wooden). Shown in "flat".

93. "Low" Relief. Enlarge twice.



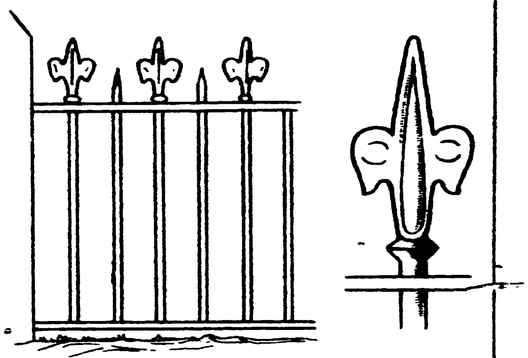
Wooden Trellis or Latticework.

94. "Low" Relief. Enlarge twice.



Wooden Fence (shown lying flat).

95. "Low" Relief. Enlarge twice.



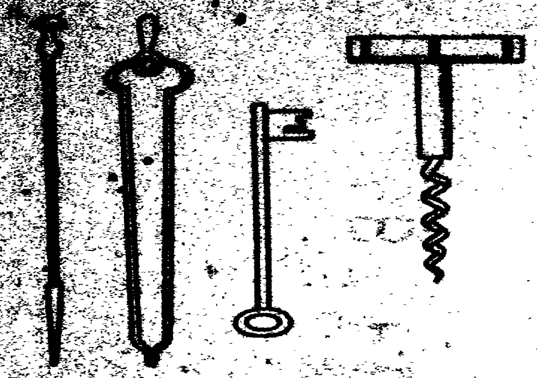
Iron Fence, with enlarged top (shown lying flat.)

PLATE XXX

Exercises 92–95. These will be modelled in slight relief, with strips of clay of regular size carefully cut out with penknife and ruler.

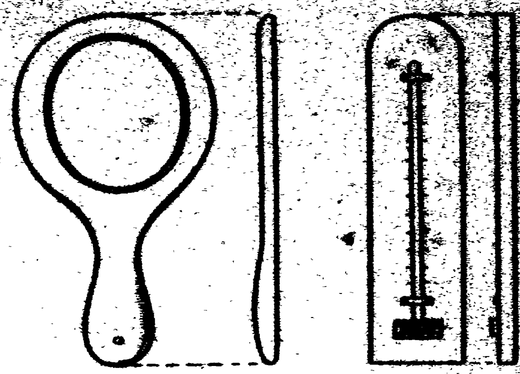
Note carefully that the back rails should be first placed in position.

96. "Low" Relief. Enlarge twice.



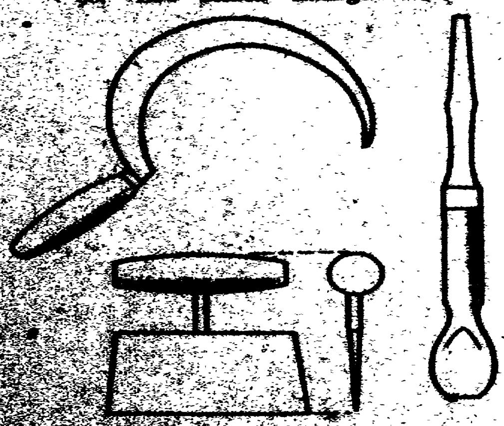
Common Objects (shown lying flat).

97. "Low" Relief. Enlarge twice.



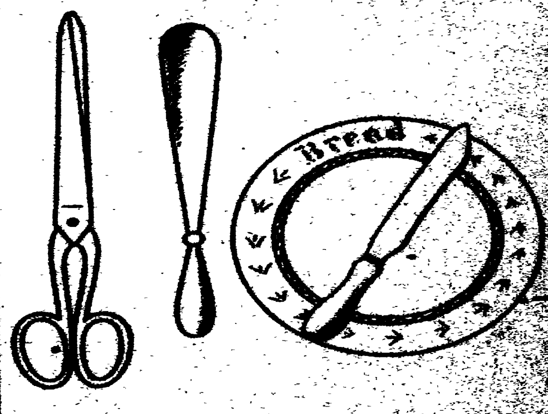
Common Objects (shown lying flat).

98. "Low" Relief. Enlarge twice.



Common Objects (shown lying flat).

99. "Low" Relief. Enlarge twice.



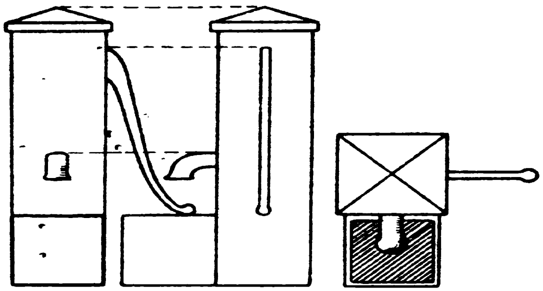
Common Objects (shown lying flat).

PLATE XXXI

Exercises 96–99. These common objects are supposed to be [illegible] flat, and can be considerably enlarged, and done either singly or in groups.

Very pleasing little devices can be suggested by symmetrically arranging these articles into clusters or groups.

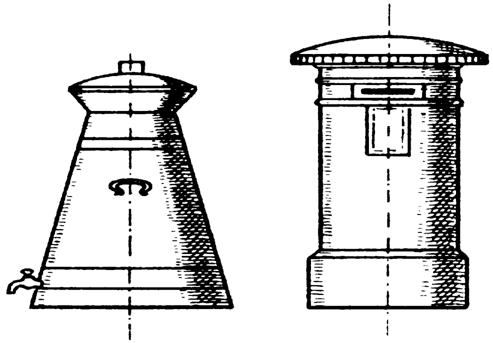
100. "Round" Relief. Enlarge twice.



Plan.

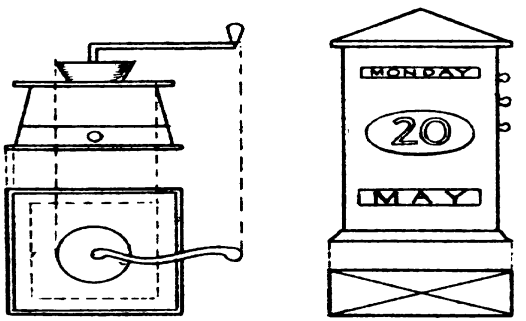
Stone Pump and Trough. Standing.

101. "Round" or "Half" Relief. Enlarge twice.



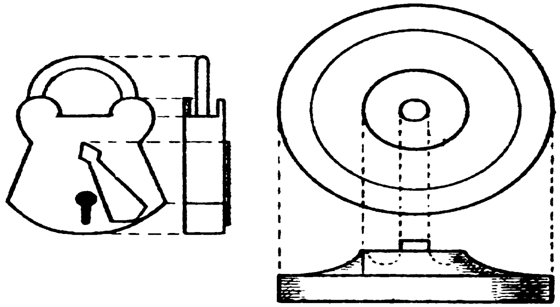
Milk Can and Letterbox. Standing, or in half relief.

102. "Round" Relief. Enlarge two or three times.



Coffee Mill and Calendar. Standing.

103. "High" Relief. Enlarge twice.



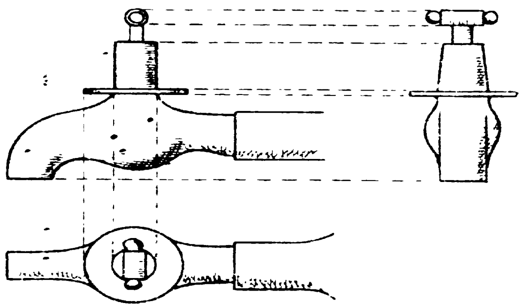
Padlock and Electric-bell Push. Full relief.

PLATE XXXII

Exercises 100-103. All these objects might preferably be modelled in the round for the sake of more useful practice.

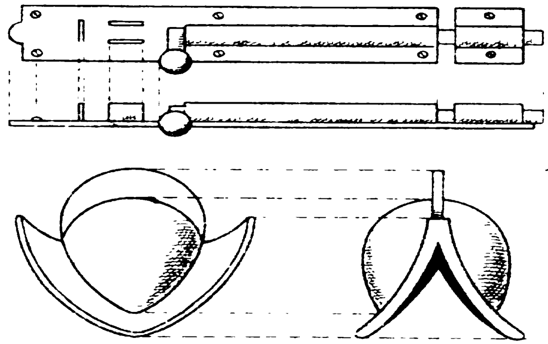
The handle of coffee mill can be made with bent wire slightly covered with clay.

104. "Round" Relief. Enlarge twice.



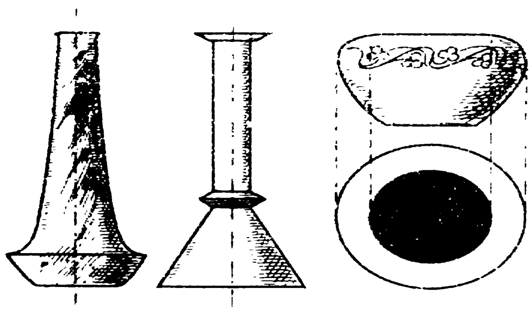
Water Tap (brass). Three views.

105 "Round" Relief. Enlarge two or three times.



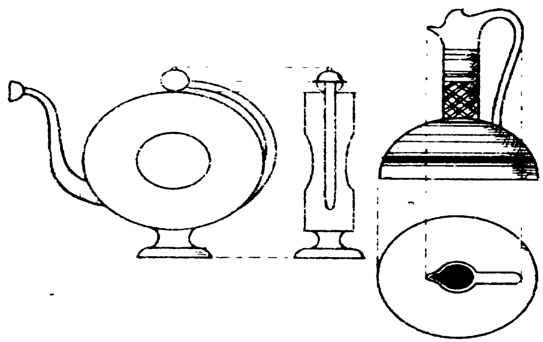
Door Bolt and Spanish Morion or Helmet.

106. "Round" or "Half" Relief. Enlarge twice.



Glazed Vases. Standing, or half relief.

107 "Round" Relief. Enlarge two or three times.



"Sprinkler" (ancient) and Greek (ancient) Vase Incised

PLATE XXXIII

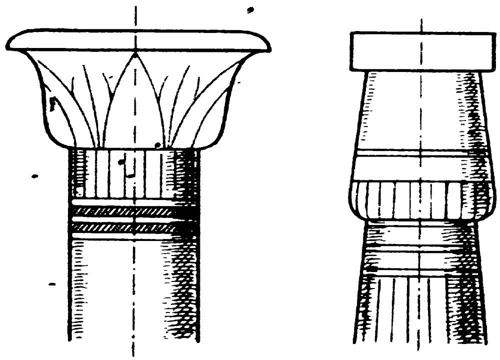
Exercises 104 and 105. These objects should be modelled in the round. The hollow under part of helmet should be cut away afterwards.

Exercises 106 and 107. These numbers deal with vase and bottle forms, and if not modelled too large should be done in the round. Note the incised ornaments. They will in substance be solid.

As an additional exercise they may be modelled in low relief on slabs.

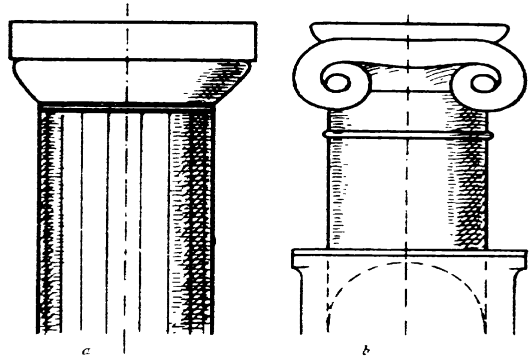
It is suggested that the upper scholars of a school might co-operate in making a *potter's wheel* for experimenting in the actual production of vase forms rather than merely modelling them by hand.

108. "Round" or "Half" Relief. Enlarge twice.



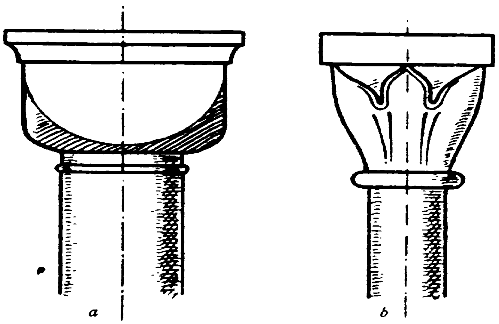
Egyptian Capitals. Pattern incised (stone).

109. "Round" or "Half" Relief. Enlarge twice.



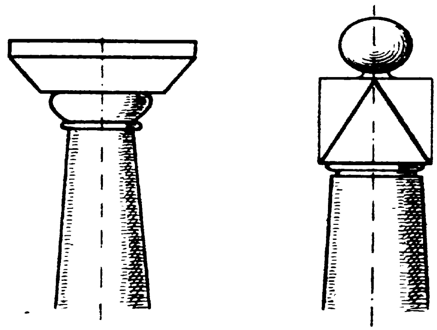
Greek Capitals. *a*, Doric. *b*, Ionic (marble).

110. "Round" or "Half" Relief. Enlarge twice.



a, Norman Capital. *b*, Gothic Capital (stone).

111. "Round" or "Half" Relief. Enlarge twice.



Modern Wooden Posts.

PLATE XXXIV

Exercises 108–111. This plate comprises architectural supports of well-known description. They may be modelled in whole, half, or quarter relief.

Exercise 109. In 109B note that the spirals come in the front plane and do not recur at the sides.

Exercise 110. In 110A the abacus is cubical, with under sides rounded off to semicircular flat face.

Exercise 111. In 110B the holes between the leaves should be drilled with tool, and surface cleared away.

112A. Cut Templates to twice size or larger. Shaded portion represents Template.

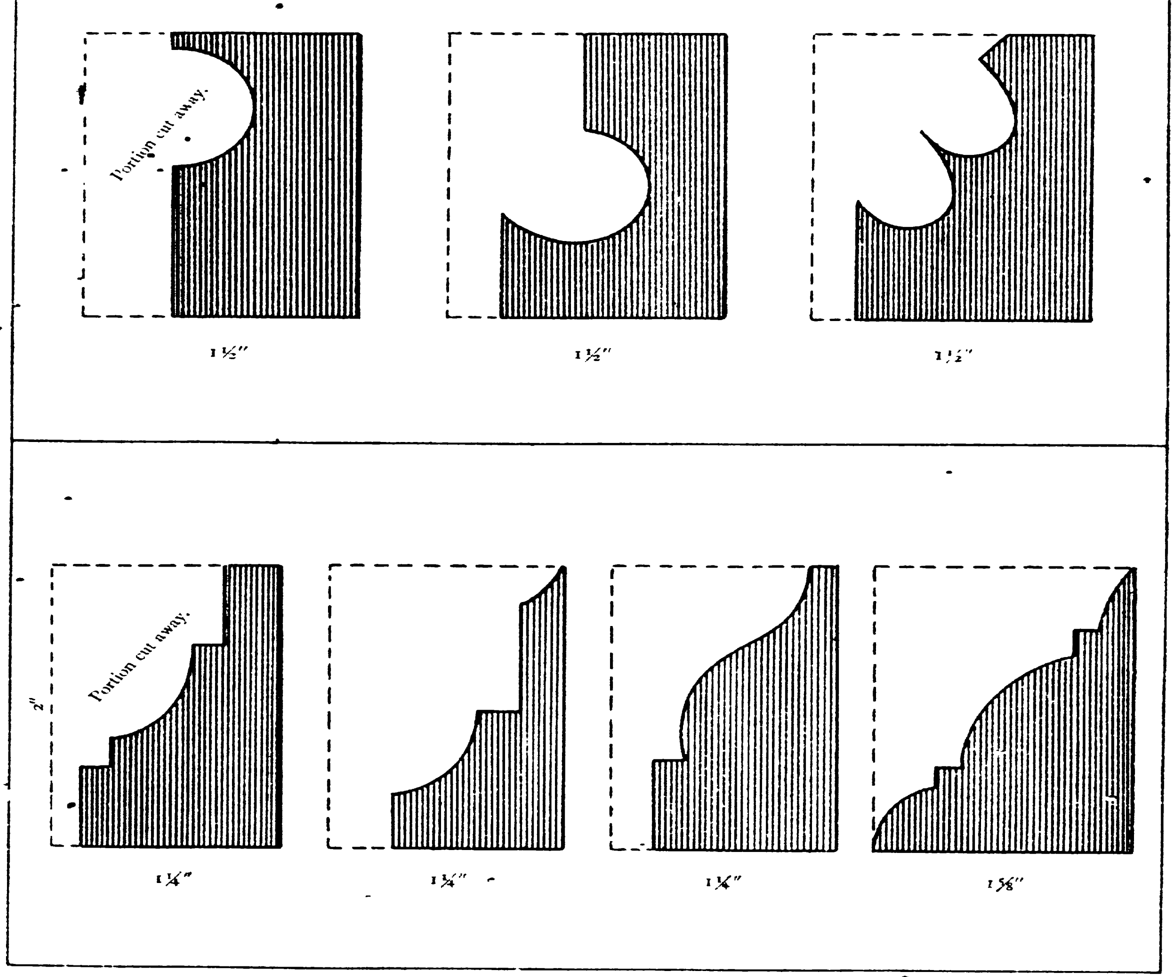


PLATE XXXV

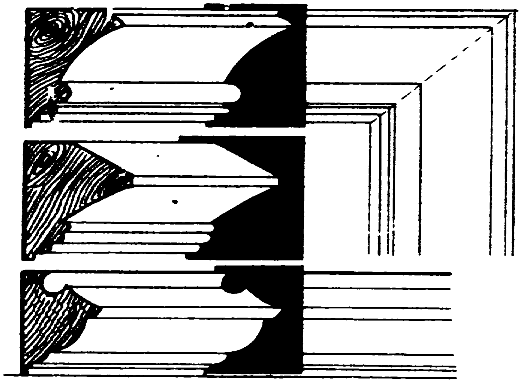
Exercises 112a and 112b. These templates, the use of which is of extreme practical value, should be cut in thin wood by each scholar in advance of the modelling lesson, either at home or in school, with pocket knife. Time would not be wasted if a special lesson were devoted to the cutting of templates.

The templates should be strictly made to a given size. It will be noticed that these outlines coincide with the section of mouldings required—they are the negatives.

An endless variety could be made by noticing the mouldings around picture frames, door panels, ceiling borders, &c.

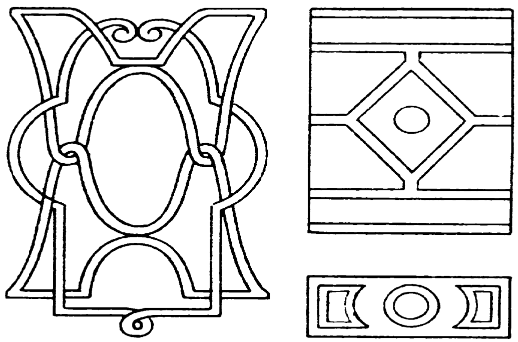
The clay is roughly built up to the general form and projection of moulding. The template is then applied and firmly dragged backwards and forwards several times over the surface of clay until a smooth and exact contour is obtained. If the template is inclined to stick, slightly moisten surface of clay.

112B. Black Shapes are the Templates. Enlarge two or more times.



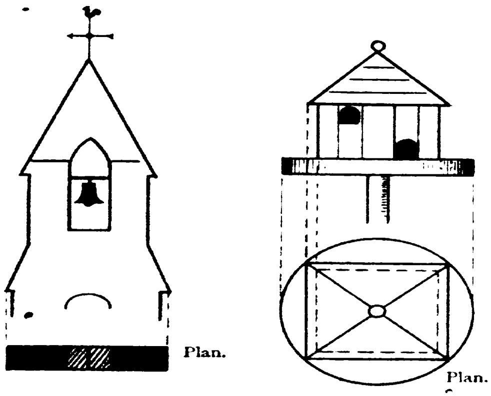
Mouldings. Templates.

113. “Low” Relief. Enlarge two or three times.



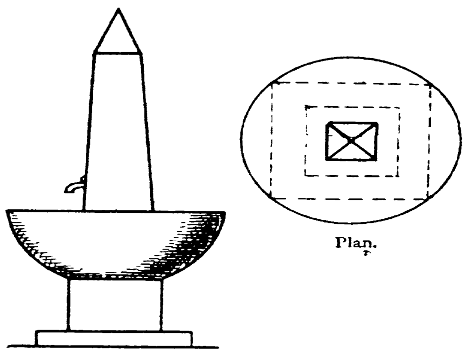
“Panelling” and “Strip Woodwork”.

114. “Round” Relief. Enlarge twice.



Belfry (stone), Dovecot (wood). Standing.

115. “Round” Relief. Enlarge twice.



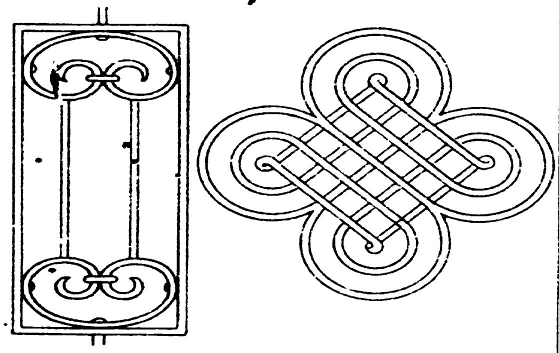
Granite Street Fountain. Standing.

PLATE XXXVI

Exercise 113. Panels should first be carefully drawn upon slabs, and borders can be made of strips of clay worked over with a tool or by small templates according to result desired. Much Lincrusta work comes under this heading.

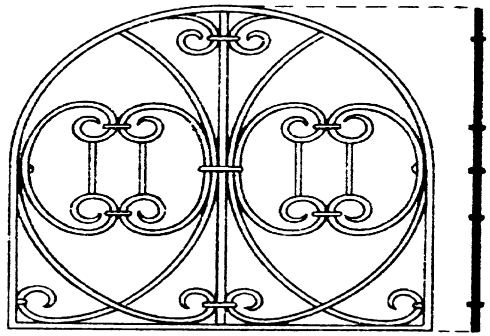
Exercises 114 and 115. Model these in the round, noting carefully the plans, leaving out support in the case of the dovecot.

116. "Low" Relief. Enlarge two or three times.



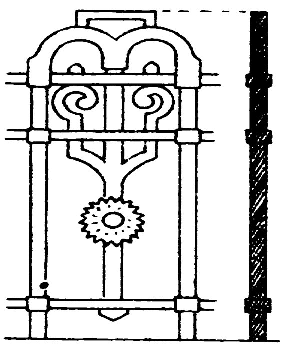
Examples of "Wrought Iron" (in "flat").

117. "Low" Relief. Enlarge two or three times.

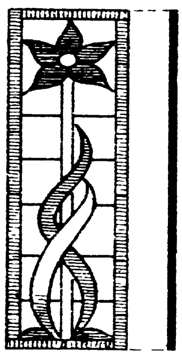


Wrought-iron "Grille" (in "flat").

118. "Low" Relief. Enlarge two or three times.



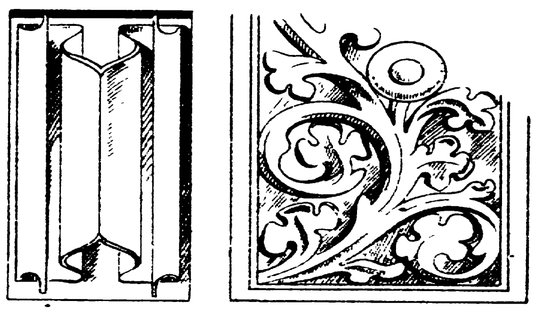
(a)



(b)

a, Cast-iron "Grille". b, Stained-glass Window "Leading".

119. "Middle" Relief. Enlarge two or three times.



Wood Carving and "Linen-fold" Panel.

PLATE XXXVII

In this and the following plate examples have been selected which, while of a simple description, are pleasing in design, and are types of the kinds of ornament which are best suited to the various materials worked, whether it be iron, wood, stone, or plaster, &c. This class of examples, which could have been considerably extended in many other materials, will give the scholar a most valuable insight into the technical possibilities of the materials in which he is designing. They should all be worked in low relief in the flat, as shown.

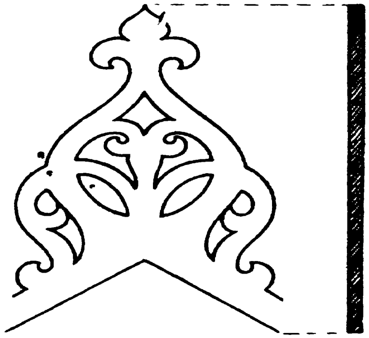
Exercises 116 and 117. Wrought iron represented by thin bars of clay should be placed over a careful drawing of the design, and the ties should be properly placed.

Exercise 118. In 118A the cast-iron bars are considerably thicker than in wrought-iron examples, and the surface of the bars should be quite evenly flat.

Only the leading can be shown in the stained-glass window (118B) indicated by the thick black lines in the design. The leading is very narrow, low in relief, and slightly rounded in surface.

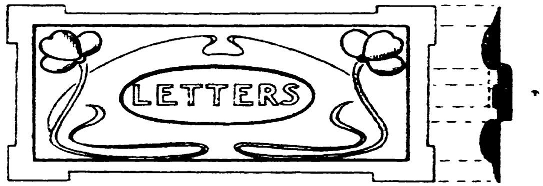
Exercise 119. The design for wood panel should be first carefully drawn. The ground is scooped away to show relief. The finish of surface is obtained by careful attention to light and shade in drawings.

120. "Pierced" Flat. Enlarge two or three times.



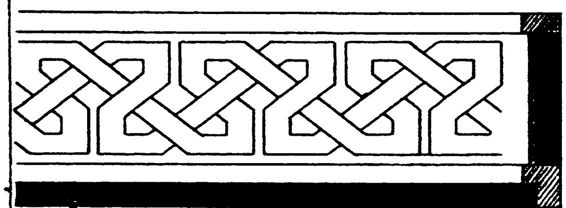
Pierced Work. Swiss Wood Fretwork.

121. "Low" Relief. Enlarge two or three times.



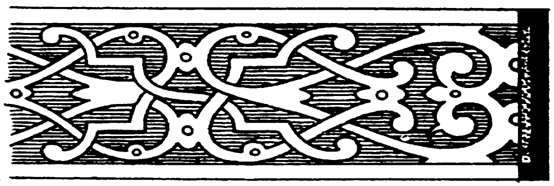
Repoussé and Gesso Work. This example is in Repoussé.

122 Very "Low" Relief. Enlarge two or three times.



Moorish "Strapwork" Tiles.

123. Very "Low" Relief. Enlarge two or more times.



"Sgraffito" Work in wood, stone, or plaster. Elizabethan Strap. Ground cut away.

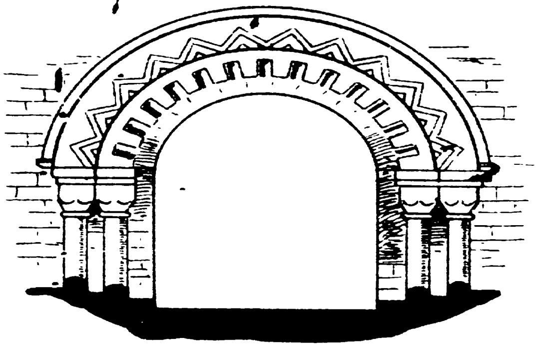
PLATE XXXVIII

Exercise 120. Flat ornament with ground and holes scooped away.

Exercise 121. Slab of clay showing depression in middle (see section). The ornament in panel is in very slight relief.

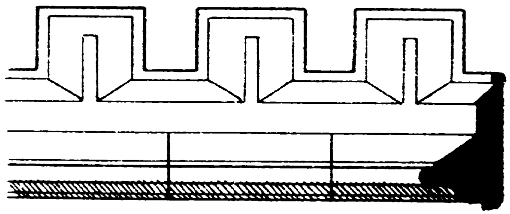
Exercises 122 and 123. These patterns require very careful setting out on slab. Make fine outline with incising tool, slightly scoop away background, retaining an even surface as far as possible. In plaster this would be called sgraffito work.

124. "High" Relief. Enlarge twice.



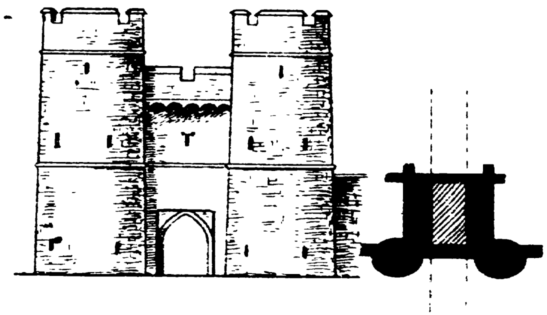
Norman Arch with "Dog-tooth" Moulding.

125. "Round" Relief or semi-detached "High" Relief. Enlarge twice.



Embattled Parapet of Castle.

126. "Round" or "Free" Relief. Enlarge three times.



City Gate. Standing. Plan.

127. "Round" Relief. Enlarge as required.

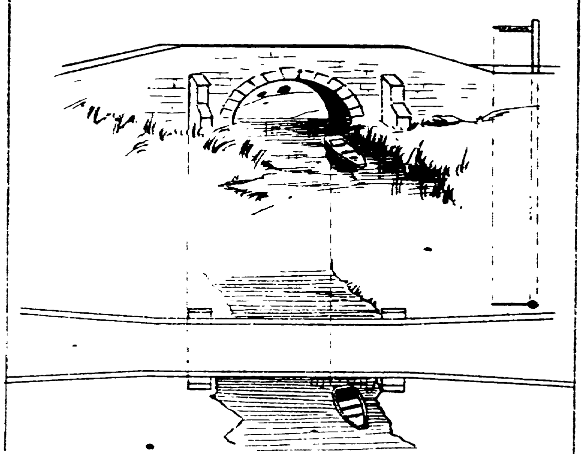
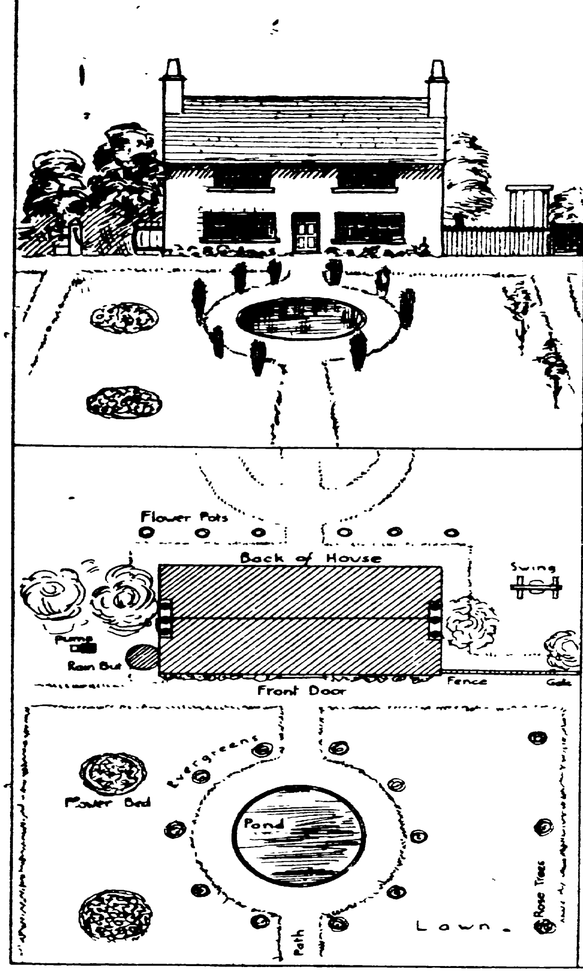


PLATE XXXIX

Exercises 124–127 These must all be worked as suggested by the drawings. The Norman arch could be modelled in relief against an upright surface. For variety a piece of glass or tinfoil under the bridge would suggest water to give reflections.

Note that the building in Ex. 126 is a quadrangle as shown in plan, with towers at front corners. No further elevation is necessary.

128. Buildings and Surroundings. Enlarge three or four times.



129. Landscape and Geographical. Enlarge as required.

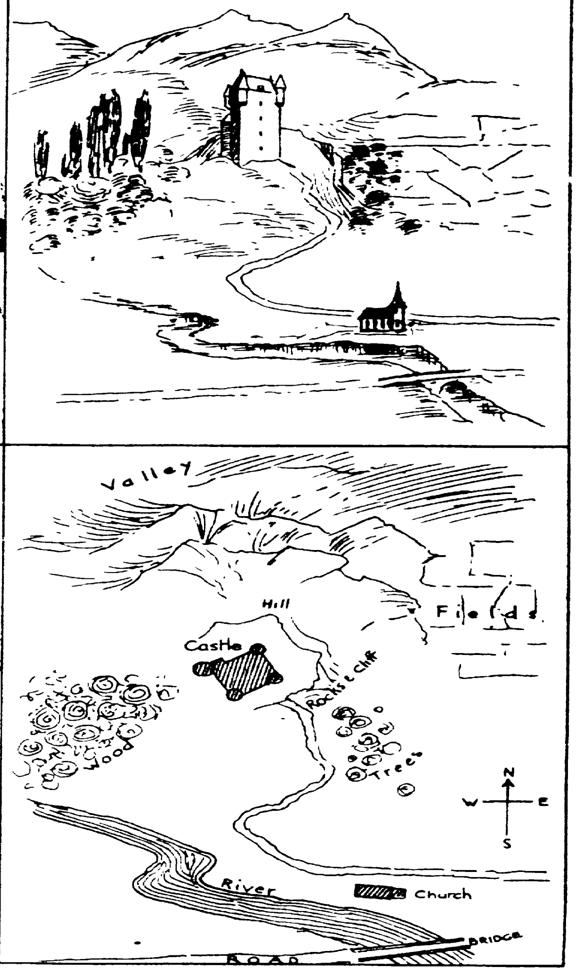


PLATE XL

In these instances we have the final application of round relief examples, and they could be multiplied to any extent. When nicely done they form pleasing and interesting models, which can be afterwards sketched realistically in perspective from several points of view.

Bookbinding

LEWES R. CROSSKEY

BOOKBINDING

Equipment.—The appliances required are not many. The essentials are noted as follows, but as will be observed many of the details, such as glue, paste, and so on, are the common stock of every house and school. All details are to be found in the *Amateur Binder's Outfit* of Messrs. Berry & Roberts, 21 St. Bride Street, Ludgate Circus, London, E.C. Also any stationer or bookseller who does some binding will be able to advise.

Sewing Press, 20 inches between Screws.
Brass Keys for Sewing Press.
Cutting (Laying) Press, with Pin, Plough, and Knife complete, 18 inches between Screws.
Pair Cutting Boards.
Pair Backing Boards.
Pair Pressing Boards.
Pair Hand Shears, 7-inch.
Pair Compasses, 7-inch.

Paste.
Paste Brush.
Glue.
Glue Pot.
Glue Brush.
Backing Hammer.
Square, 18-inch.

Finishing Tools.
Set of Pallets.
Fillet, No. 2.
Small Gas Stove.
1 set Brass Type, No. 162.
Type Holder.
Gold Cushion.
Gold Knife.
Paring Knife.
Cutting out Knife.
Knocking-down Iron.

Strawboards.
Millboards.
Binder's Cloth.
Leather.
Thread.
Needles.
Headband.
Brown Paper.
1 book Gold Leaf
Dry Glair.
Bottle of Varnish.

Among mediaeval craftsmen the binding of a book was a high art, and the great masters of the craft are spoken of with reverence to this day. Examples of their work are eagerly sought for by art collectors, and many of these old bindings find an honoured place in our art museums. In the case of bookbinding, modern requirements have not, as yet, completely destroyed the art, as they have done in the case of many other artistic crafts: there is still a demand for well-bound books.

To apprehend the general principles of binding, a good plan is to take an old volume

(one of no more use) to pieces. It will be found to consist chiefly of three elements: (*a*) the cover, (*b*) the sheets folded, and (*c*) the tapes, sewed to the sheets that attach the sheets to the cover. The cover consists of two rectangular pieces of millboard upon which is glued a piece of cloth with a space the breadth of the back of the book lying between the pieces of millboard.

This is what is found in an ordinary *cloth-cased* book, such as a school "Reader". A volume *bound* in the older and narrower technical sense, the sense in which *binding* is used in this article, has the same three elements, namely: (*a*) the cover, (*b*) the sheets, and (*c*) the cords attaching sheets to cover. But in detail the methods differ in some important respects. While in the "Reader" the cloth case is made up and completed separately from the sheets, and glued on to the attaching tapes, in a bound volume the plain uncovered boards are laid on the sheets, and the attachments, generally of *cord*, are laced into the boards. The leather or cloth which is to cover the boards is then stretched over the boards and neatly glued on with edges all nicely turned in. With this brief explanation it will now be possible to understand the several stages of the binding of a book.

Sizes of Sheets.—The binder receives the printed matter for a book in a number of bundles of large sheets printed on both sides. (Fig. 1 shows one side of an octavo sheet on which are printed 8 leaves, equal to 16 pages.)

The different sizes of the sheets are known by trade terms, such as *foolscap*, *crown*, *post*, *demy*, *royal*, *imperial*, &c. Names are given to books of different sizes, and these names are founded partly on the sizes of the sheets used and partly on the folding, i.e. whether 8vo, 4to, folio, 16mo, &c. Thus we have foolscap 8vo, foolscap 4to; crown 8vo, crown 4to, &c.

Folding the Sheets.—Folding the sheets is the first operation in the binding of a book. The printer has so arranged the pages on a sheet that when they are folded, as described below, the pages will follow one another in their proper order.

Fig. 1 shows the pages that fall on one side of the sheet. On the back of these are the other eight pages of the sheet. A bone folder (a sort of rough paper-knife of bone) is taken in the right hand, and held at about the centre of the sheet; the sheet is then taken up by the left hand at the top right-hand corner and bent over until pages 3 and 6 come as nearly as possible over pages 2 and 7. Care should be taken to see that the headlines and numbers at top of each page coincide. The paper, while being held in that position, is pressed down the centre with the folder. Pages 4, 13, 5, and 12 will now be uppermost. Pages 12 and 5 are now folded over so that they exactly cover or correspond with pages 13 and 4, and the fold formed as before. Pages 8 and 9 will now be uppermost, and will only require to be folded on each other as before to make the pages of the section follow in their correct order. If this operation has been done neatly the headlines should run evenly throughout, or, in other words, should exactly correspond with each other.

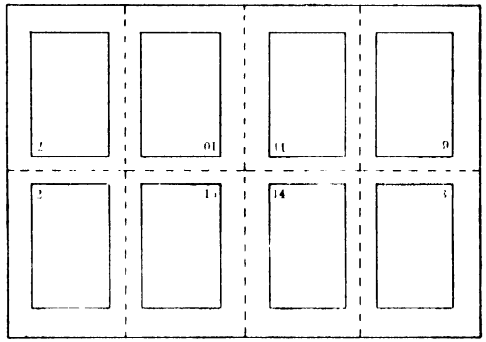


Fig. 1. Folding

Plating.—If there are illustrations printed on single leaves apart from the text (called *plates*), these are inserted in their proper places by running a narrow strip of paste along the edge of the plate and fastening it separately to a leaf of the book.

Gathering.—When the sheets are folded, a printed number or letter will be found at the bottom of the first page of each section. This indicates the order in which the sections of the book are to be bound. This number or letter is called a *signature*.

If several copies of the same book were being bound simultaneously, the folded sheets

or signatures should be laid out on a table in piles, each pile consisting of sheets of the same kind, and the several piles following each other in the order of the signatures. One sheet should then be taken from each pile, beginning with the last signature. These sheets when gathered will form the complete book.

Collating.—This process is simply one of checking after gathering. The book is held firmly, at the top of the fore edge, by the right hand; and all the sections are fanned out at the back, until each shows the signature or number. The operator can thus see at a glance if the sections are following each other in proper order.

Pressing.—At this stage the book should be put between boards and put under a heavy weight, or, better still, into a copying press or screw press. This pressure is applied to give a firm feeling to the book.

The sheets have now to have *cords* (see *supra*, p. 136) affixed, and the number of cords has to be decided on. *Three* is the least number possible: one in the middle and one at each end; *four* is better, even for a small volume (say the size of a "Reader"); for a considerable volume *five* is desirable. Decide on the number of cords, say four. Then proceed to knock the book up square at the head and back—that is, the sections, held between the hands, are allowed to drop alternately on the head and on the back until these edges are quite level. The book is then put in the *laying press* (see fig. 2) between boards. These boards should be kept half an inch from the back edge of book. The position of the cords is then marked off in pencil on the back of the book. By reference to fig. 3 it will be seen that in addition to the four cords there is a mark at each end, that is, six marks for four cords; if there were five cords, there would be seven marks. All the marks have, presently, to be actually cut with a saw, as shown in fig. 2. The four central cuts or slits are for the cords, the other two (one at each end) are called "kettle-stitch marks", and are to enable the thread to be introduced as explained below. After this general exposition we can now resume going through the processes in detail.

Sawing.—The book being screwed up between boards in the *laying press*, as explained, and the position of cords and "kettle-stitch" marks duly ruled in pencil, a slit has now to be made with a saw, across the back at the places indicated by the pencil rulings. A small

tenon saw is used for the purpose. The slits should be about $\frac{1}{16}$ inch deep. These are to receive the cords, and around these the thread is wound in the process of sewing. Ordinary string will serve. "Soft cord" is what the special kind of string is called. It must be strong and at the same time soft.

Sewing.—Sewing is the next stage. It is done on a sewing bench (fig. 3). *b*, *b*, *b*, *b*, are the cords tied to a loop on a cross bar A, and carried in the saw cuts in the sections and through slits in the board B, B. The ends of the cord are tied to metal pins underneath the board B, B. Proceed as follows: The first section of the book is opened and the left hand inserted.

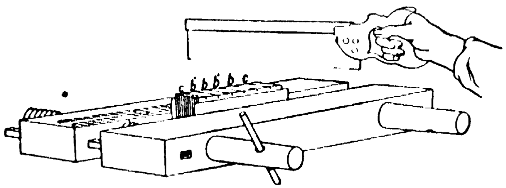


Fig. 2.—Sawing

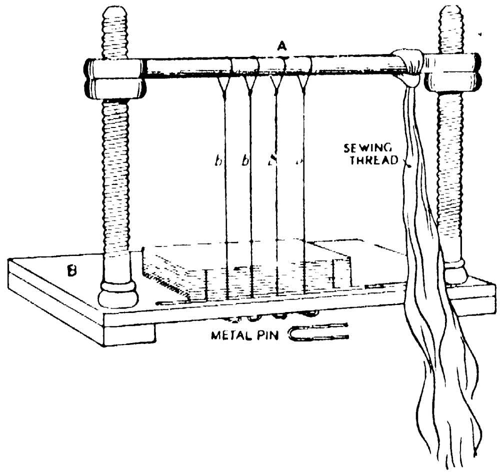


Fig. 3.—Sewing Bench

The thread is introduced by the needle into the kettle-stitch mark on the right, and is passed along to the first cord; the needle is drawn out at the first opening at the side of the cord nearest the kettle-stitch mark, and passed over the cord and along the inside of the section to the next cord, and so on until the end of the section has been reached. It is then passed back, catching up the cords in the next section in the reverse order, and when the

end of the second section is reached the loose end of thread is taken up and tied, forming the "kettle stitch". Care should be taken with the kettle stitch, as a great amount of the strength and flexibility of a book depends upon it. It is formed by leaving about 4 inches of thread hanging from the first sheet, and then, when the thread is taken out at the end or top of the second sheet, fastening it by a knot to the end which has been left hanging from the first. The kettle stitch in all the sections after the first two, is formed by making a chain stitch.

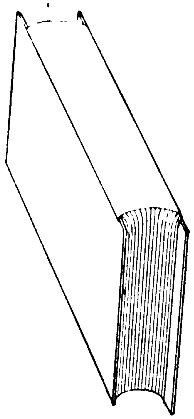


Fig. 4

When the first section is sewn, the second section is placed on the top of it, and each of the other sections is added after the preceding one has been sewn. When all the sections are sewn the cords are cut, leaving lengths of cord an inch and a half long to fasten to the boards. These cords thus sewed into the book are laced into the boards as explained hereafter.

End-papering.—The book is now ready for end-papering. The end papers consist of two pieces of four pages, which may either be plain or coloured. These are attached by paste at the beginning and the end of the book. The end papers serve a double purpose: first, to protect the book, and, secondly, they aid in holding the book and its case together.

Rounding the Back.—The edges of the back are now hammered over with an ordinary hammer. This is done in order to reduce the swell of the sewing. This done, thin glue is spread evenly over the back; when nearly dry, the back is rounded by hand.

Jointing.—The volume is placed once more in the laying press between boards[1] whose edges are kept to within ⅛ inch of the top of the back on each side (fig. 2). The rounded back is now hammered firmly till the edges of the back protrude over the edges of the retaining

[1] Note that these boards are not the boards of the volume to be presently discussed.

boards and thus form the "joints", as these protruding edges are called (see fig. 4). The joints are for the boards to fit into. They form a hinge. See the present volume.

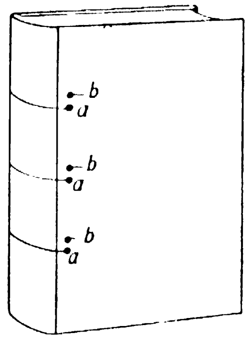


Fig. 5

a, a, a; *b, b, b*, Holes bored in boards.

The Boards.—These have now to be prepared from millboard, which can be procured in large sheets, and can be roughly cut up with a pair of strong scissors. The boards must be cut to the same size as the uncut sheets. The space occupied by the joint, and the ultimate cutting of the edges of the book, cause them in the finished book to project at top, tail, and fore edge beyond the sheets, as seen in any ordinary volume, e.g. the present work.

When the size of board required has been decided upon, mark off in outline with pencil and T square, then cut with a sharp knife and steel straightedge; this ensures a clean-cut edge. The plough can also be used successfully for this part of the work (see sketch, fig. 6).

Lace-holes must now be bored in the boards with a brad-awl (see fig. 5). The position of these holes is adjusted to suit the position of the cords (fig. 5).

Lacing in the Boards.—The volume is now removed from the laying press. The ends of the cords are moistened with paste and are then inserted at *a* and drawn out at *b* (fig. 5). The cord is then unravelled slightly and cut level with board, and the holes through which it has been drawn closed by laying the board on a piece of iron, or other hard, smooth surface, and hammering it smooth. The remaining cords are treated in the same manner.

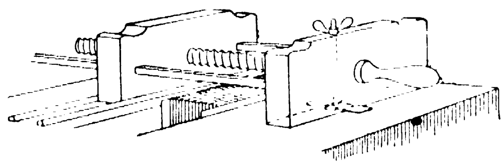


Fig. 6

Cutting the Edges.—The edges are cut as follows: Sharpen the knife of the "plough."

(fig. 6) on a sandstone, finishing off with an oilstone. Next fit the knife into the plough. The head of the book is to be cut first; push the front board of the book down, thus leaving a small "cut-off" at head. Another thin piece of board is put in between the book and the back board: this is called the "cut against". Put the cutting boards (oblong boards having the front thicker than the back) on each side of the head of the book, and see that the front cutting board lies along the edge of the drawn down book-board. Put the book in the laying press, the front board level with the cheek of the press, and screw up. Work the plough gently at first, and keep working the screw slowly in the process of cutting. Take out book and set it square for tail cut by pushing down the board, repeating the other arrangements as for head cut, and cutting as formerly. To cut the fore edge, draw pencil lines on book along the edges of the front and back book-boards. Throw back book-boards, tie the book with a tape about 1½ inches from the back, and knock up square. Take a pair of cutting boards and place one on each side on the pencil lines, leaving the front board down a little. Then cut with plough. When this is finished take out and loosen tape. The book will now resume its original shape with rounded back.

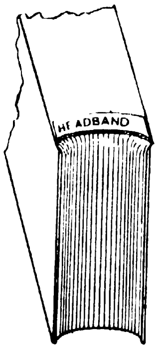


Fig. 7

Headbands.—It is usual to put on headbands (fig. 7). These are made of silk thread wound round pieces of vellum or thin board. Machine-made headbands are also used. The headbands go at the head and tail of the book.

Lining.—As the cords are embedded in the sawslits on the back of the sections, the back, when covered, will be a smooth surface; but, before covering, a necessary operation termed *lining* takes place, which is done as follows: Put the book, with fore edge downwards, in laying press; cut a piece of brown paper the exact length of back and about three times the width; glue the back, lay on the paper, leaving about ⅛ inch of the glued

back exposed on the right-hand side of the book. Rub down the paper. Now turn or fold over the paper from the left-hand side of book, and rub down on the right side on to the glued eighth inch left exposed on right, as above. Fold back the surplus paper and cut off the piece that is over with a sharp knife. This gives what is called an "open back". If, instead of a plain back, it is desired to have one showing bands, it will be necessary to put on strips of leather or string before the book is covered (see fig. 8).

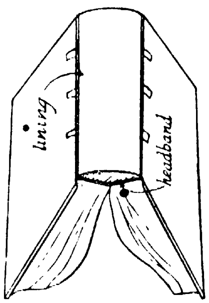


Fig. 8

Covering.—The leathers for the back and corners are cut to size and shape, and the flesh or reverse side of the leather is pared at the edge with a sharp knife. The cut-out leather should be an inch longer than the book, leaving half an inch to project over the top and over the bottom. The corner leathers should have a similar margin allowed for folding in, and a small piece should be cut off the corner of the leather which comes to the corner of the board. The leather is then pasted and put on to the corners of the board and to the back of book. The back leather is turned in on the open back at the top and bottom (see fig. 9). If the cutting and paring has been properly done the edges will double under quite smoothly.

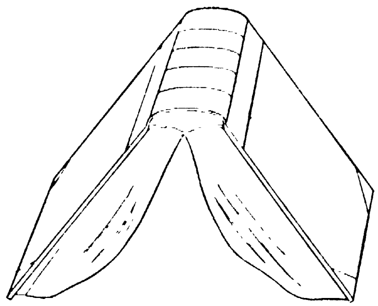


Fig. 9

Putting on Cloth or Paper Sides on the Books and Pasting Up.—For half-bound books the leather on the sides and corners of the board is pared down and cloth or paper sides put on with paste or glue. Before pasting up end papers cut out two pieces of blank paper $\frac{1}{8}$ inch less than length of board and a $\frac{1}{4}$ inch less than the breadth. Paste these on

to the inside of the boards as linings, then paste down the end papers of book. Rub down, fold back the boards, and lay aside to dry. When dry, press for a few hours to make the book firm.

Lettering.—In a hand-bound book the lettering and ornamentation of the covers and back are executed by separate tools. Each letter, for instance, is in the form of a metal die fixed into a handle. The impression of the letter is made by pressing the die, when slightly heated, into the leather; that of the ornamentation on the leather is made in the same manner.

Ornamentation.—The leather is washed with paste water and pencilled in with glair. One or two coats of glair are given, according to the tools to be used. When the glair is dry, rub the impression with vaseline and lay on the gold with a piece of cotton wool. Take the tool at medium heat and impress in the design made. When finished, rub off superfluous gold with para rubber.

Pressing the Finished Book.—After all the operations have been completed the book should again be put into a press or under a heavy weight for at least overnight.

Note.—The gold to be laid on is usually lifted with a piece of cotton wool, which the operator first passes over his hair or over his cheek to make it slightly sticky. The cotton wool with the adhering gold is then pressed down on the ornament or letter to be gilt.

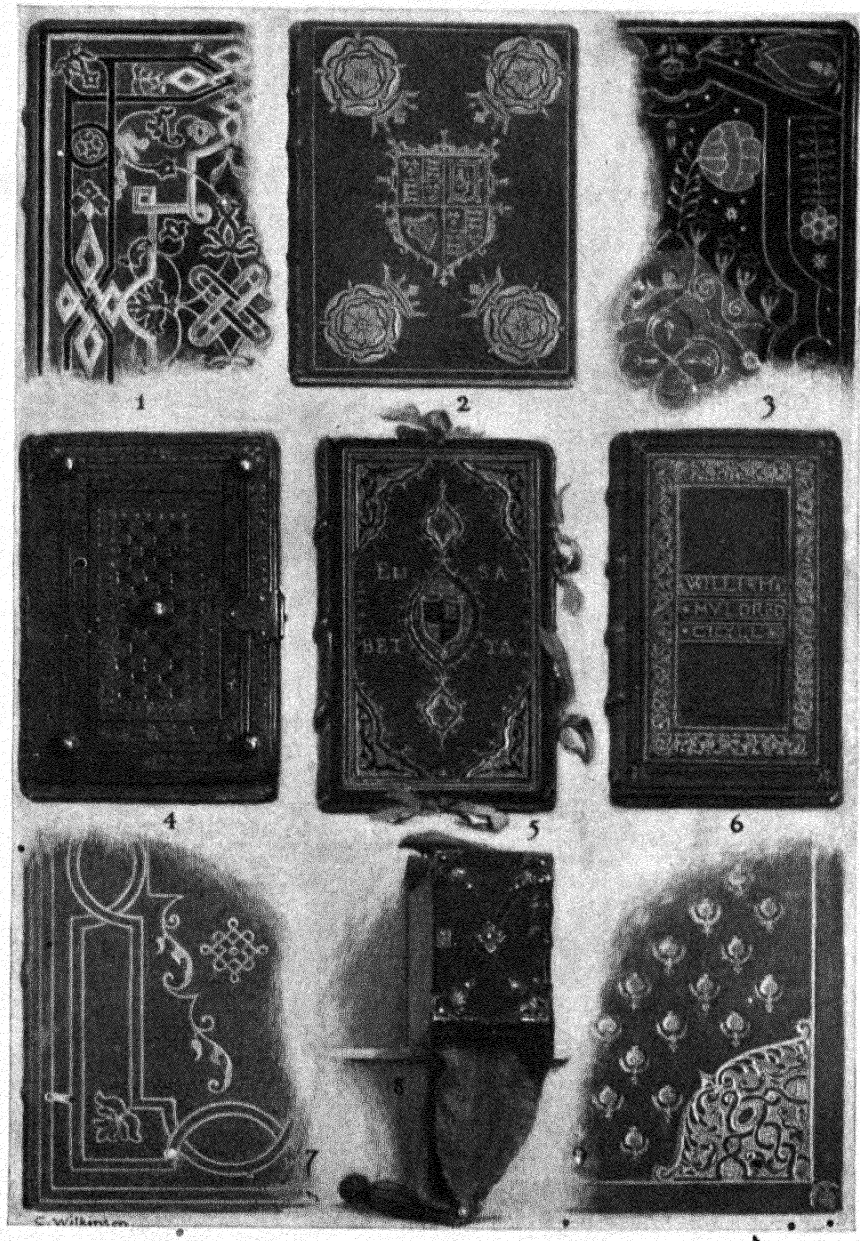
Leather Binding.—Teachers will be interested in the illustrations of bookbinding shown in the accompanying plate.

1. Coloured binding with strap-work pattern: brown morocco (book dated 1548).

2. Brown calf binding with English royal arms in centre and crowned Tudor roses in corners (book dated 1540).

3. Black morocco binding inlaid with crimson and yellow—"cottage design" (Bible, 1658).

4. Pale-brown calf binding, "blind-stamped", with small gilt roundels, metal bosses, and clasp (book, Venice, 1474).



BOOKBINDING

Old Bindings in Leather

(See description in text)

5. Book bound for Queen Elizabeth (Venice, 1560), with arms in centre and name *Elisabetta*; red morocco inlaid with red and pale-brown morocco, corner designs black on gold.

6. Brown calf binding with *William* and *Myldred Cicyll* (Lord and Lady Burghley), stamped on covers (book dated 1528).

7. Venetian binding (book dated 1523), citron morocco with geometrical interlacing design enclosing scroll-work and Arabic knots.

8. Binding for German MS. of prayers (date, 1485), brown leather, brass corners, boss in centre, &c.; leather continued at the bottom in a long hanging strip tapering to a point, and finishing with a plaited button for attachment to the girdle or dress.

9. Binding done for James I (book dated 1616), olive morocco, corners and thistles in yellow (the royal arms in the centre—not shown).

Simple Leaded Glass Work

LEWES R. CROSSKEY

SIMPLE LEADED GLASS WORK

INTRODUCTORY

The use of leaded glazing in small squares is due to the fact that in early times glass was very expensive. To break a large window pane in those days would have been a calamity which could only be put to rights at a great cost, whilst a small leaded pane was much more easily renewed.

In recent years there has been a notable revival of this form of glazing in connection with the vogue for "antique" furnishings of all kinds. Leaded glass is extensively used not only for windows, but for panels for doors and screens, in designs which harmonize with modern decorative notions. Even where a window is not completely treated in this way, framed panels of leaded glass work placed inside, at the bottom of the window, are useful both for the pleasing effect they produce, and for giving privacy to the room.

For ordinary transparent "leaded lights" sheet glass is usually selected, but for better work patent plate (that is, sheet glass polished on both sides) is preferred, as it is entirely free from distorting waves or inequalities of thickness. Where obscured windows are required, cathedral glass and muffled glass are often used.

The execution of simple designs, either in plain or tinted glass, with rectangular or diamond-shaped panels, is quite within the scope of school manual work and many beautiful

shades of coloured glass can be got, which lend themselves admirably to the production of artistic results.

DESIGNS SUITABLE FOR SCHOOL WORKSHOP

The beginner should confine his operations to geometric designs formed by straight lines; if curves are attempted, the nearer they are to straight lines the easier they are to work. Fig. 1 shows a panel design such as a beginner should attempt. The reproduction given here is reduced to half-scale, but the coloured working drawing should be made the same size as the object to be produced.

A full-size drawing is also required showing the "cut line"; i.e. the centre lines of the lead strips which hold the little panes of glass (fig. 2).

List of Tools and Materials Needed

The tools and materials necessary, which can easily be obtained at small cost at any glass stainers, are as follows:—

1. Strips of lead.
2. Pieces of glass of suitable colours.
3. An implement to open out the lead strips.
4. Stopping knife.
5. Cutting knife, for cutting the leads.
6. Roller cutter, for cutting the glass.
7. Some nails.
8. Soldering iron or copper bit.
9. Cementing material.

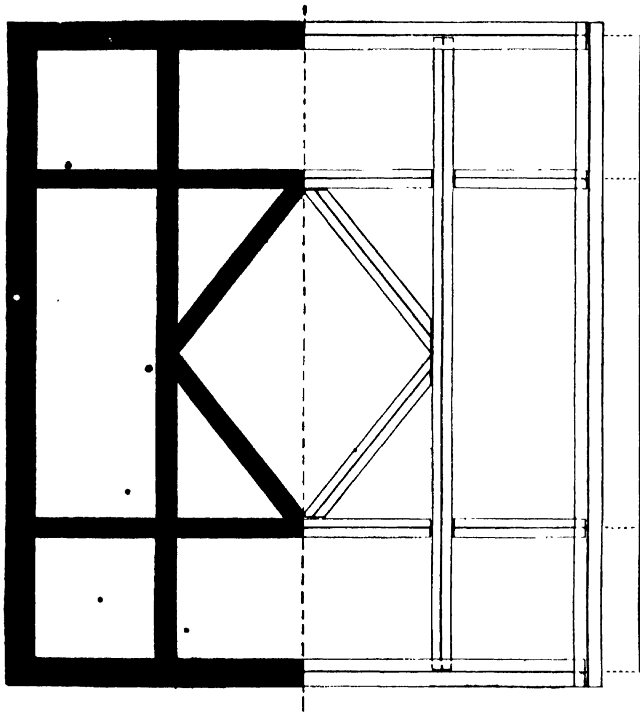


Fig. 1.—Simple Design for Leaded Glass Panel (half-scale)

The right-hand half of the design is given in outline in order to show how the leads are cut to fit into one another.

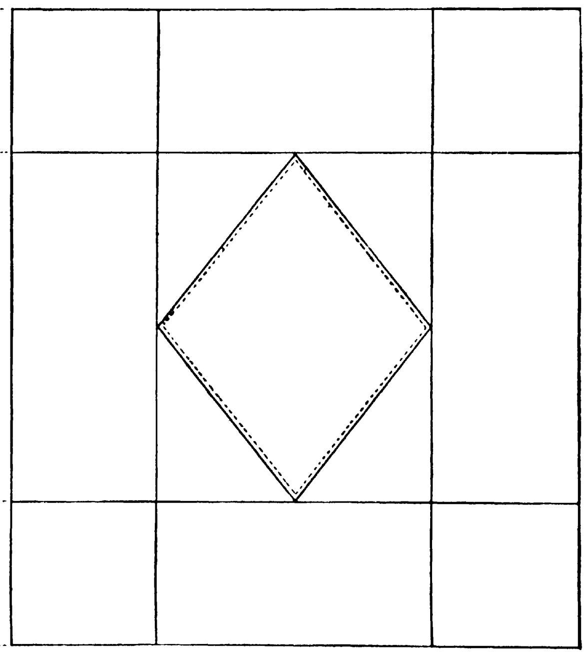


Fig. 2.—"Cut Line" prepared from Fig. 1 (half-scale)

The dotted lines within the central diamond-shaped piece show the size of the glass for that particular opening.

THE LEAD

The strips of lead are pliable and are made in various sections (fig. 3). The upright portion (*a*) is called the core. The leads can be obtained in lengths of from 3 to 4 feet, and in sizes which range in width (i.e. across the face) from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch; and they are sold by weight. Before the leads are brought into use they need to be stretched. This stretching is accomplished by placing one end under the foot and drawing the strip upwards with a pair of pliers, twisting it round in the process, so that at the last stretch it is perfectly straight. When this has once been done the lead will, if left alone, remain straight. When it has been straightened it has to be trimmed off at the ends, and then it is quite ready for use.

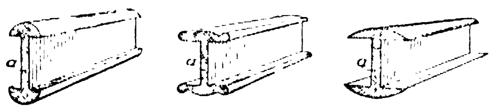


Fig. 3.—Various Sections of Leads

a, Core.

THE GLASS

Both cathedral glass and muffled glass are inexpensive, and are obtainable in a wide range of colours. Other kinds of decorative glass which may be mentioned are: Antique, Ambetti, Venetian, Flemish, and Opalescent. "Antiques" are particularly fine, both as regards texture and colouring, but are somewhat costly. In small pieces, however, their price will not be found prohibitive, and judicious use of these rich mellow hues will be found to lend character and distinction to designs which might otherwise be lacking in interest.

THE TOOLS AND HOW TO USE THEM

Craftsmen use the quaintly-named "**lathakin**" (fig. 4) for opening out the lead strips so that the glass can be inserted, but a short stick of hard wood (fig. 5) answers the purpose satisfactorily.

Fig. 4.—Lathakin (half actual size)

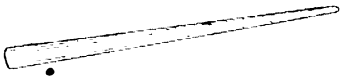


Fig. 5. Stick of Hard Wood

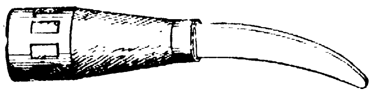


Fig. 6.—Stopping Knife

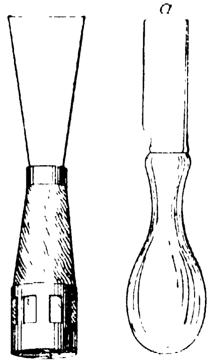


Fig. 7 Fig. 8

Cutting Knives

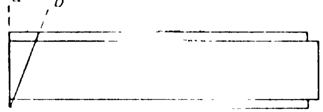


Fig. 9

The **stopping knife** (fig. 6) is used for shaping the ends of the leads, for turning back the leaves of the outside leads, &c.

The **cutting knife** (fig. 7) is a thin, sharp, chisel-bladed tool for cutting the ends of the lead. As a rule the two last-named tools are weighted in the handle, so that they can be used for tapping in the nails which hold the glass and lead temporarily in their place. An old table knife, with the blade broken off and sharpened as at *a*, fig. 8, makes a suitable cutting knife when the "tang" is fixed in a round handle. The knife is used vertically, and care must be taken that the lead is cut squarely, as shown at *a*, fig. 9, not as at *b*.

In the case of the softer kinds of glass, such as are used for leaded lights, a **wheel cutter** will be found very satisfactory, and is in common use in leaded-glazing workshops.

It consists of a small steel wheel with a sharp edge fixed to a handle (*a*, fig. 10). The handle is held by the thumb and finger, and it passes between the first and second fingers (fig. 11). When cutting, the cutter is drawn towards the operator. Too much pressure must not be used; the wheel should only just bite the glass. A little practice will give the necessary experience.

When breaking off the glass it is held by the finger and thumb of each hand, and the break is made by pressing downwards. If the shape to be cut is not formed by straight lines (fig. 12) the glass will not break off so easily. It has to be held by one hand while the under side is tapped by the top of the wheel cutter below the cutter mark. The tapping must be very gentle, and as it proceeds a silver line will appear along the line of the cut. When the line stretches from end to end of the cutting the piece is easily broken off.

Fig. 10.—Wheel Cutter, for Cutting Glass

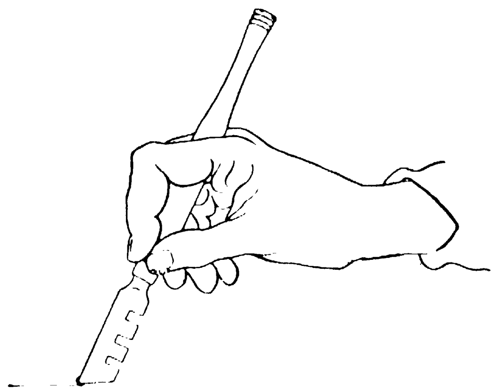


Fig. 11.—How to use the Wheel Cutter

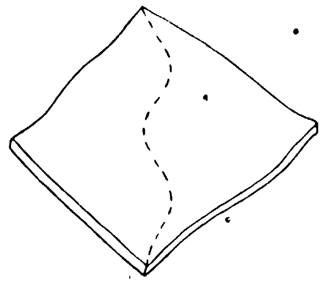


Fig. 12

Any kind of nails can be used for the purpose of fixing the glass and lead temporarily

in position, but perhaps the most convenient will be found to be $1\frac{1}{2}$-inch or 2-inch last nails (nails used by shoemakers to fix the leather to the last).

The **soldering iron** (fig. 13) consists of a short thick rod of copper mounted on an iron stem, with a wooden handle. The copper portion has a pointed end. The tool is used for soldering the leads together at their intersections. In workshop practice the convenient copper bit illustrated in fig. 14 is frequently employed for the purpose. Gas is supplied through a flexible tube attached to one end,

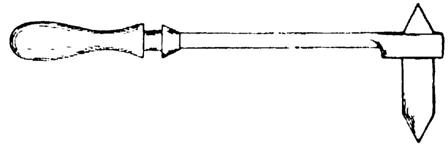


Fig. 13.—Soldering Iron

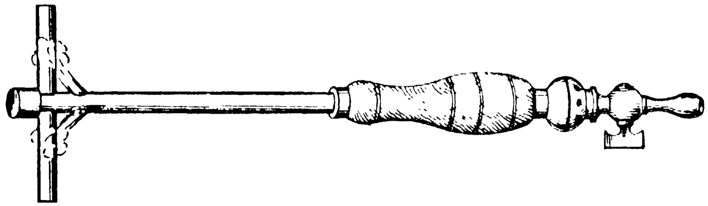


Fig. 14.—Soldering Tool or Copper Bit

and the supply can be regulated by the tap to suit any requirement. With this instrument soldering can be effected with great rapidity.

OPERATIONS

Cutting the Glass.—The shape of each piece of glass used in the design has to be traced from the "cut line", and cut out of cardboard. These shapes are called gauges. A gauge must be cut $\frac{1}{16}$ inch less than the size shown on the cut line, to allow for the thickness

of the core (fig. 3). The dotted lines within the central diamond-shaped piece, fig. 2, represent the size of the gauge for that particular opening. When a shape is to be cut, the required gauge is placed on the glass, and one side cut at a time by running the cutter along the edge of the gauge. Always endeavour to place the gauge so that the pieces to be broken off are angular, as in fig. 15, *a*, *b*, *c*, *d*, *e*.

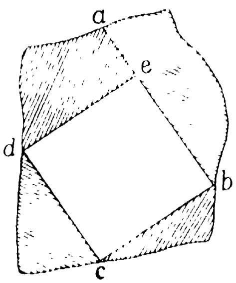


Fig. 15

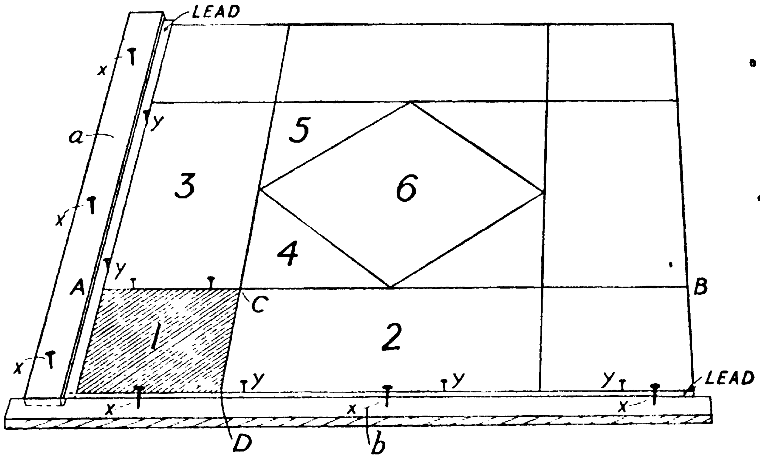


Fig. 16

Building up the Design.—The cut line is pinned down on a table or bench, with the longer edge of the design nearest to the operator. Two laths of wood, each about $\frac{3}{8}$ inch by 2 inches, are placed on the drawing at right angles to one another, one being parallel to the near edge, and the other to the left-hand side of the drawing (fig. 16, *a*, *b*). The laths are kept in position by nails lightly driven into the bench (fig. 16, *x*). Next take two leads $\frac{3}{8}$ inch or $\frac{1}{2}$ inch wide, cut to the lengths required, push the one into the leaf of the other,

lay them against the laths, and secure temporarily with nails (fig. 16, *y*, *y*, &c.). These outside leads are always deeper and heavier than those used for the rest of the work. The first piece

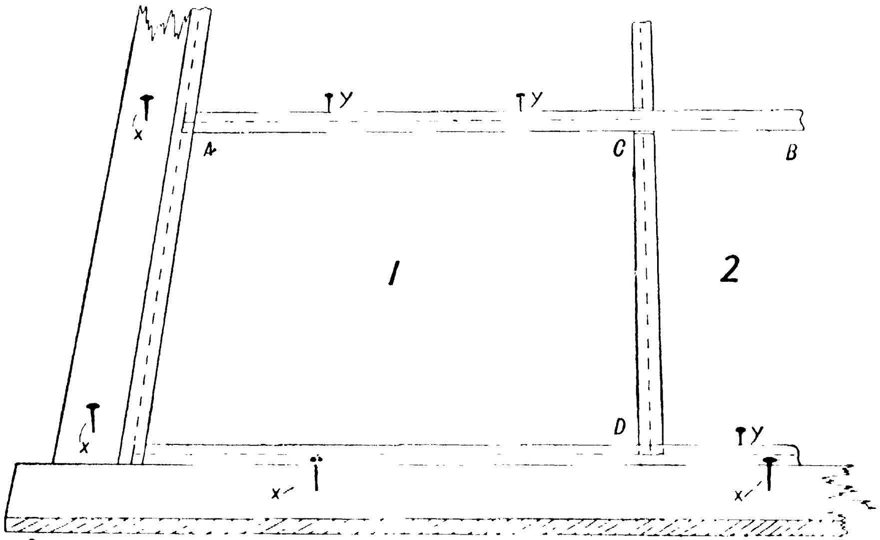


Fig. 17

of glass is then inserted so that two of its edges bear against the cores of the outside leads. The stopping knife (fig. 6) is used to push the glass pieces and leads into their right places, and its loaded handle is used for tapping in the nails to hold them there. It is essential that

the order in which the glass pieces are placed in position should be such that the thrust is always on the fixed straight edges.

Now cut the lead for the cross strip A B, fig. 16. This is one of the vertical lines of the design, and the fact of it being all in one length will give strength to the work. Lay the strip in its place on the cut line, thrusting one end into the outside strip (fig. 17, A), and fix its position with nails. Next cover the remaining side of glass No. 1 with a strip which butts closely against the cross lead at C, and is thrust into the outside lead at D (fig. 17).

In a similar way proceed to place glass No. 2 in position, and so on until the cut line is covered. Finally, put round the two remaining outsides lead strips similar to those used first, then tack on two additional laths to complete the rectangle, truing the whole up carefully and correctly with the square. The leads should be closed down on the glass pieces with the stopping knife.

Soldering.—The joints must first be greased in order to make the solder adhere. Rubbing with a tallow candle is quite effective, but it makes the joints too conspicuous when the work is polished. A better plan is to dissolve the tallow in linseed oil and let the mixture cool. When cold, it can be applied with a paste brush. While the joints are being greased, the copper bit of the soldering iron should be heated in a fire or Bunsen flame. Only a moderate heat is necessary, just sufficient to melt the solder; if the copper is made red-hot, the solder is at once burned off. The exact heat required can only be found out by observant practice. After heating, the working face of the tool must be well and smoothly tinned with solder. To do this the point is carefully filed and then dipped in powdered resin, and the solder at once rubbed and melted on the filed surface.

Next hold the stick of solder close to a joint, and touch it with the heated tool, so that a drop of solder falls on the place where it is needed. Spread the solder with the iron until it is smooth, and the operation is complete.

When all the joints on one side have been treated, the laths may be taken up, and the leads on the reverse side trued up where necessary, and soldered.

Cementing.—Cementing is an important process, and must be carefully carried out, otherwise the work will not be air- and water-tight. The cement is made with finely-powdered whitening, saturated with pure linseed oil. A little terebine is added to make the mixture set quickly, and lampblack to make the colour the same as the lead.

The cementing must be done immediately the work leaves the bench, so that it may have as long as possible to stand and set. The cement, mixed to a thick paste, is applied with a short stubbing brush, which is worked backwards and forwards and round and round until the cement has penetrated right into the heart of the leads. This must be done on both sides, and then rubbed over with whitening and the palm of the hand. The work should be allowed to dry for four or five hours, and then a pick, a kind of sharp-pointed spike, must be run round the edges of each pane, the work brushed with a handbrush, and left to set. Finally the windows should be polished with black lead. The principal secret of rendering leaded work air-tight and water-tight is to allow the cement to stand at least a week, longer if possible, to harden properly. Great care must be taken in handling the completed work, as it is not rigid until supported by a frame.

EXAMPLES OF DESIGNS

In figs. 18, 19, 20, 21, examples are given of elementary designs for panels for windows, doors, and screens. There is practically no end to the possibilities of beautiful treatment in this kind of work, but it is essential that the lines should be kept simple and dignified in character.

No rules can be laid down as to the best combinations of colours for the purpose. The

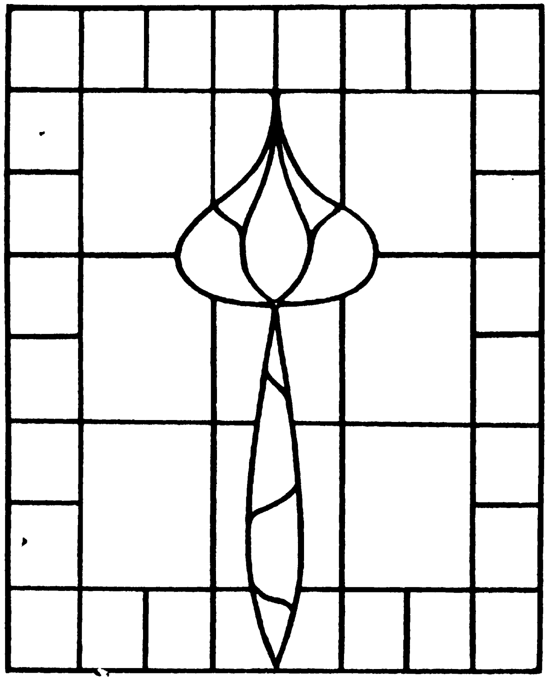


Fig. 18

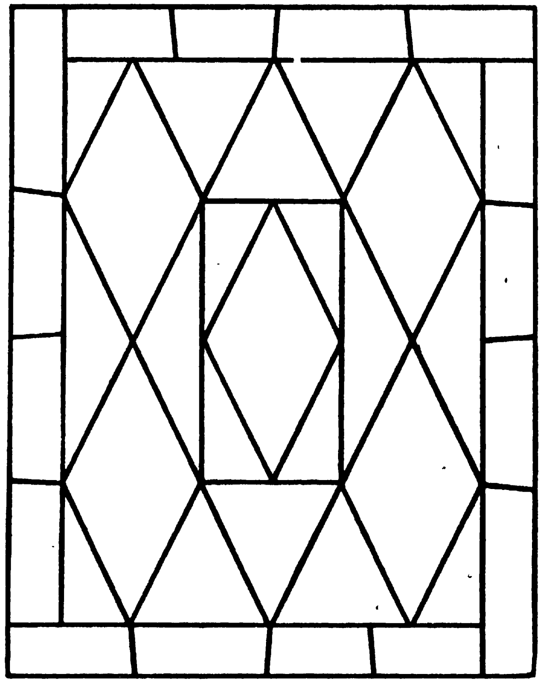


Fig. 19

Designs for Leaded Glass Panels

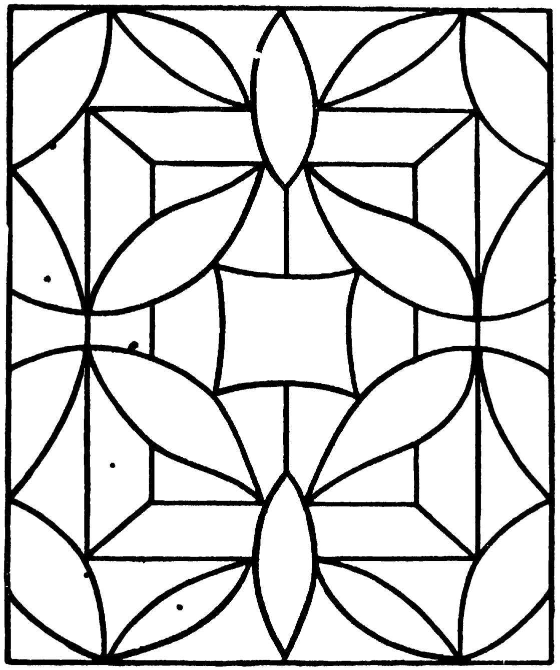


Fig. 20

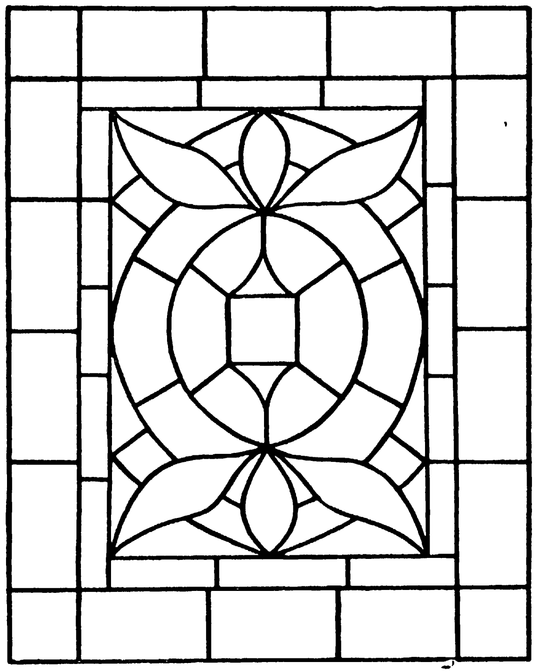


Fig. 21

Designs for Leaded Glass Panel.

craftsman must exercise his own taste in arranging suitable colour schemes. There are many fine examples of leaded glass work in our cathedrals and churches, which may appropriately be studied in this connection. The difference, however, should be noted between glasses which are coloured in the process of manufacture, such as those referred to in the present article, and glass which is stained or painted with transparent pigments. The latter is a difficult art, and quite outside the range of amateur work.

Field Geography

G. LINTON SNAITH, B.Sc.(Lond.)

FIELD GEOGRAPHY

CHAPTER I

Chain Work and Mapping

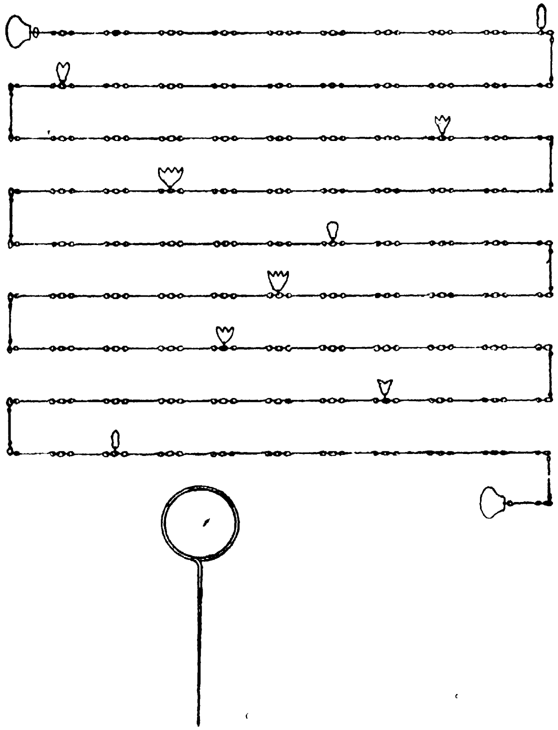
The Chain. The bought chain is of steel, or sometimes of galvanized iron, 22 yards long, and is divided into 100 links, each tenth link being marked by a certain shaped brass tab as seen in fig. 1. The handles are included in the total length. Failing a chain a very good substitute can be made from string knotted to represent links, and with a small brass tab of special shape made for every tenth link, as in the bought article.

Accompanying the chain are ten arrows, as shown. If the steel or other chain be stretched to its full length and examined carefully, then the length of each link in inches and decimal of a foot can be calculated.

The Tape.—This is easily obtained, and is usually marked in feet and inches; hence, when it is used in conjunction with the chain, the chain readings must be reduced to feet and inches, or vice versa.

The Cross-staff.—This is shown in fig. 2 and is made of wood. It is attached to a long pole supported on a wooden base. It can be made very easily in the woodwork shop or at home. Care must, however, be taken that the holes marked A and B are exactly opposite one another, and likewise that the holes C and D are opposite each other. Not only must it be so, but the cross wires in these holes must also be exactly opposite. The head

must be perfectly rectargular and of a good finish, otherwise errors will rapidly enter into the observations when in use. The top of the cross-staff measures about



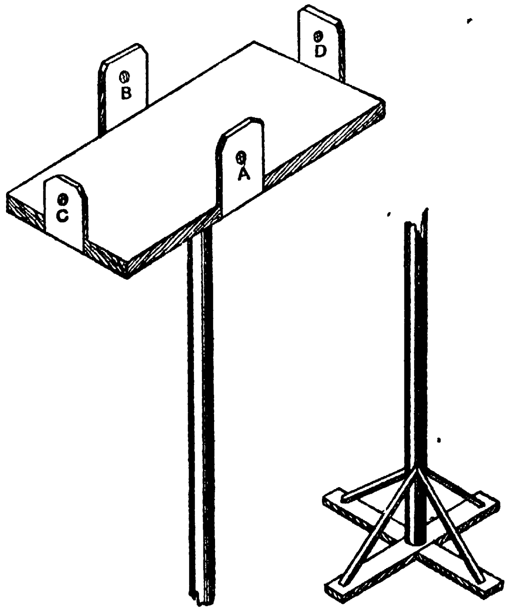


Fig. 2

15 inches by 6 inches, which is sufficiently large to combine accuracy with portability. Other forms can, of course, be designed, which will be quite as effective and suit the purpose. Try to design your own cross-staff.

Ranging Poles.—These are long round poles about 6 feet by $1\frac{1}{2}$ inches or $1\frac{1}{4}$ inches diameter, painted black and white alternately for every foot of length. It is also better for them to be shod with iron for entering the ground. It is usual to have about six or eight of these poles.

METHOD

(*a*) **Chaining a Line.**—Suppose we wish to find the length of a long field, two ranging poles must be fixed, one at the beginning and the other at the end of the line to be measured. There should be two boys, a leader and a follower. The former holds the chain in his hand by one of the handles and draws it out, being careful to keep in a straight line with the pole at the extreme end of the field. This is usually managed by the follower giving hand-signs to his leader which way to go, sighting him with the extreme pole. To do this, of course, the leader must face the follower for his instructions.

When the chain is fully extended the leader fixes in the ground his first arrow, and then advances pulling his chain with him (clear of the arrow). He is followed, of course, by the follower. When the latter comes to the arrow he appropriates it, and takes every care that he does not drop or lose it. This routine is followed throughout until the whole distance is stepped. Now the question is: "What is this distance?" Well, the answer to it is contained in the follower's hand, for he counts his arrows, and the overlap (if any) of the chain at the last ranging pole.

(*b*) **Taking Offsets.**—Suppose, now, the area of a field is to be found. First the main chain line must be decided upon. This should run as nearly as possible down the middle of

the area to be measured. A pole must be placed at the start, and called X as in fig. 3, then Y must be fixed at the other end of the field. This line XY is now the **Main Chain Line**.

The distance from X, as above, must be measured to the point opposite to Z approximately, where a ranging pole has previously been placed; and the cross-staff must be fixed so that A and B on the cross-staff are in a line with X and Y. If this is done correctly by the boys sighting through, then C and D on the cross-staff are sure to be at right angles to the main chain line. The cross-staff is next moved so that Z can be sighted through C and D. Then, if O is the point on main chain line where the base of the cross-staff is resting, OZ is said to be an **offset**. This is measured with the tape, and the distance on the chain for XO is found and recorded in the **Field Book**. This stepping-out process is continued along XY till approximately opposite some other point, when the cross-staff is again used as before. This is continued till Y is reached, and the results are entered up. The field book should then show some sort of entry akin to the following:—

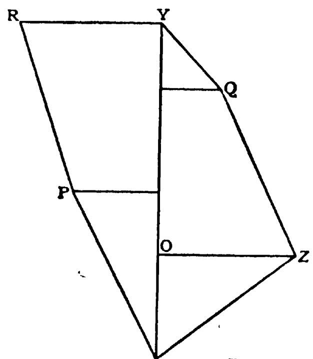


Fig. 3

	to	
	B	
50′ to R	6.6	
	4.9	20′ to Q
30′ to P	3.4	
	1.2	40′ to Z
	X	
	from	

This field should be plotted to scale on drawing paper and its area calculated by the following methods:—

(i) Triangle = $\frac{1}{2}$ base × perpendicular height.
(ii) Trapezium = $\frac{1}{2}$ sum of parallel sides × perpendicular height.

On the finished copy the points of the compass as found during the survey of the field should also be shown. Next, as an exercise to test the correctness or otherwise of the work, the drawing from R to Z should be measured to scale, and calculated what it should be. Then it should be stepped out with the chain to get the actual distance, and the error in the observations should be found. Other cross points or diagonals should be tested in a similar way.

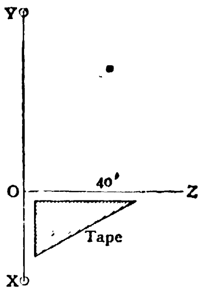


Fig. 4

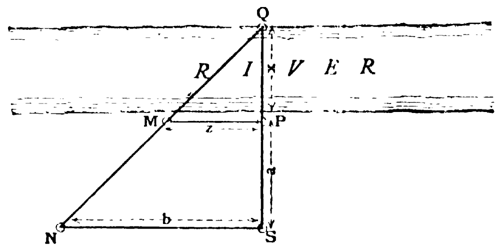


Fig. 5

(*c*) **Another Method for taking "Offsets".**—Suppose you are on the main chain line as above, near to the first position of the cross-staff at O. Take your tape and arrange it in the form of a triangle with sides 12 feet, 16 feet, and 20 feet, and you will see that if a boy is placed at each corner, the tape can be pulled into a right-angled triangle. If so arranged, that the right angle lies on the main chain line, then one side will be perpendicular to it, and in this way the point Z can be located as in fig. 4.

Notice here that any triangle with its sides in the ratio 3 : 4 : 5 has a right angle in it.

(*d*) **Chaining across a River.**—Fix upon a tree or some obstacle, Q, at the opposite

side of the river, and place ranging poles at P and S in a line with it. Then with cross-staff or tape get M and N at right angles to Q S, and at the same time by sighting get them in a line with Q (fig. 5). You can work it out mathematically as follows, or take the result for granted:—

$$x : z :: (a + x) : b$$
$$\text{i.e.} \quad bx = z(a + x)$$
$$\text{i.e.} \quad x(b - z) = az$$
$$\text{i.e.} \quad x = \frac{az}{b - z}.$$

Another Method also suggests itself.—Repeat as above to get Q, P, and S in a straight line (fig. 6). Sight P M and S N at right angles to Q S, and make P M = S N. Bisect P M at L, and if a pole is placed here, and another at R, so that Q, L, and R are all in one straight line, and also M, N, and R are in one straight line, then M R = Q P.

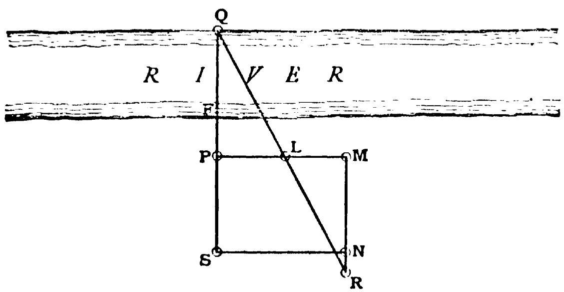


Fig. 6

Now, by arranging P near to F we can approximate to the width. This method may also be used for finding the sloping distance across the river where Q S is an oblique line and not perpendicular to the river's course. Many other graphic methods suggest themselves for gaps, buildings, and insurmountable objects occurring in a survey.

(*c*) **Triangulation.**—Another useful chain exercise is to split your area or field into a series of triangles for the purpose of getting long distances chained and the application of

another formula. Area of a triangle $= \sqrt{s(s-a)(s-b)(s-c)}$. Suppose ABDEFC to be the area (fig. 7). Fix ranging poles at these points and chain out A B, B C, and C A. Then $s = \frac{1}{2}$ the sum of the sides, and a, b, c the lengths taken separately. After the operation, survey the same field by means of the *main chain line* method, and *find if any error exist between* the two results.

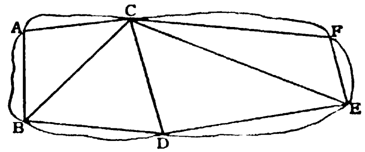


Fig. 7

CHAPTER II

Plane-tabling and Map-making

The Plane-table consists simply of a drawing board with a screw attachment underneath for fitting the table to the top of a tripod. The tripod mentioned in Chapter III for the theodolite will do for the plane-table.

An ordinary small blackboard becomes a *plane-table* if propped on four stools so that, after testing with spirit levels, it is horizontal. To buy a plane-table costs a few shillings; but not more than three or four can profitably work at it, as if they do they trip about over the legs and spoil the work. A device to keep all the boys occupied is to have drawing boards drilled with two holes near the edge, and after passing string through them to let the boys sling them round their necks and by the use of levels to get them horizontal. They then become very good substitutes for those sold by firms. The sighter can consist of a piece of gas-pipe tubing with cross wires mounted on two V-shaped blocks.

Method of Using.—Suppose A B C D is the school hall (fig. 8), choose some *base* line,

X Y say, 30 feet long. Mark X and Y in chalk. Set up the plane-table as at $fghi$. Place a sheet of drawing paper on it and rule a line $x'y'$ in the middle, and arrange that the line drawn is to scale. Sight along the base, so that $x'y'$ lies along X Y. Arrange x' to be over X, and when the table is moved to Y then y' will be over Y. The sighter should be arranged with one extremity over x'. A and B, and C and D should be sighted. These directions should be drawn on the paper in pencil, and then the table moved along to Y, and the observations and drawing repeated. Care should be taken that the table is at the same height above the ground in each case—as seen by the plumb-bob. Where these directions intersect gives the plan of the hall on a small scale. A study of fig. 9 will show this.

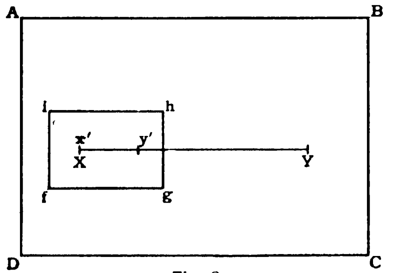


Fig. 8

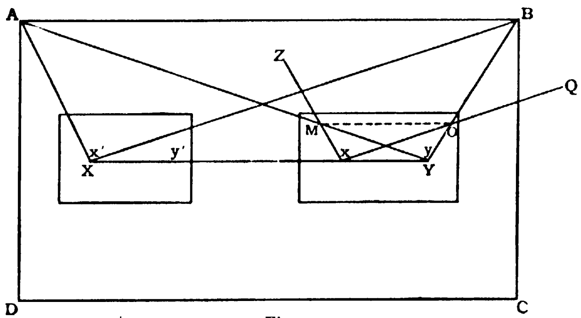
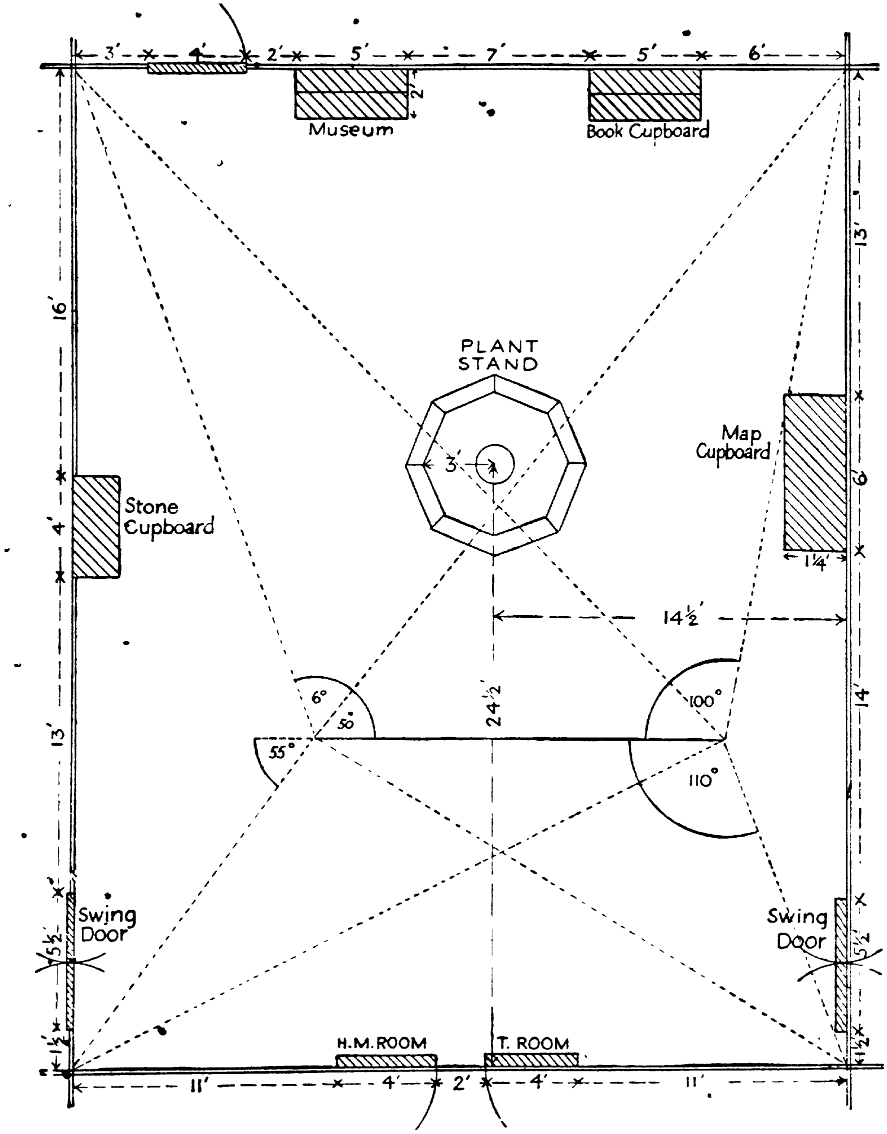


Fig. 9

At x' we get directions x'A and x' B first; then, on moving to y, we see that xZ is still parallel to x'A in first position. Now yA will cut xZ at M say; similarly, yB will cut xQ at O. Hence

$$MO : AB :: yM : yA$$
$$\text{but } yM : yA :: yx : yx'$$
$$\text{hence } MO : AB :: yx : yx'$$

So the sides are proportional to one another as the base is to the first line. Hence we get the hall to scale. It is best to start in the schoolroom first; then, when you go out into the parks or fields, the boys know what to do



3′
4′
2′
5′
7′
5′
6′
Museum
Book Cupboard
16′
13′
PLANT
STAND
3′
Map
Cupboard
6′
1¼′
14½′
Stone
Cupboard
4′
6°
50°
55°
24½′
100°
110°
14′
13′
Swing
Door
Swing
Door
5½′
1½′
H.M. ROOM
T. ROOM
11′
4′
2′
4′
11′

Fig. 1c

and get on with it. Impress upon them to keep off the tripod legs. Fig. 10 shows some work done by boys aged thirteen years.

CHAPTER III

Theodolite Work

The Theodolite.—A school instrument can be made cheaply, which will answer the purpose quite as well as an expensive one. From fig. 11 we see that it is made in four parts: A, the tripod; B, the circular disc; C, the vertical rod; and D, the sighter.

A. Each leg is made in two parts—the bottom tapering section and the side strips. These parts can be riveted together at X. B is seen to have three projections, each bored to receive a stout pin, which secures the side strips of the tripod. In the centre is drilled a hole into which a circular piece of metal tubing is fitted, either screwed or not, to receive

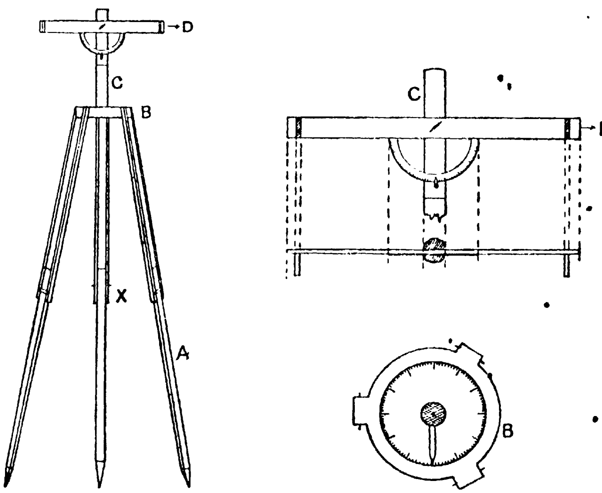


Fig. 11

the peg at the bottom of C. C can be made from any round piece of wood—preferably a small portion of an old-fashioned curtain pole, screwed, if possible, to fit into the hole in the centre of B. The top portion of C is cut flat; to it is screwed a metal protractor. D is made in different designs. A straight piece of brass tubing open at each end may be used. It is secured by means of a thumbscrew to the top of C. It is better to have the top of B graduated from 0°–360°, with a needle or index attached to base of C for readings in a horizontal plane. Thus we have two possibilities—angles in a horizontal plane and angles in a vertical plane. If any boys have access to a science laboratory they can make a spirit level from a piece of glass tubing, which should be fitted into the top of B, recessed out to receive it. On the under side of B a small screw for string and plumb-bob should be attached. Boys will find it very convenient if the theodolite, when finished, is able to be taken to pieces; for then, when going on country excursions, it is portable and easily packed away.

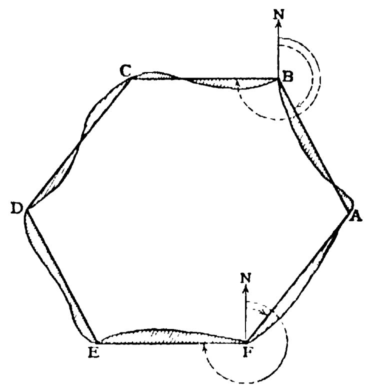


Fig. 12

Field Survey.—See fig. 12. Start from A and sight B and F, at the same time reading the angle. This gives the internal angle B A F of the figure. Chain off the side A B, and repeat process at B for angle A B C. Repeat this cycle till you arrive at A again. Reproduce from your field-book sketch the actual drawing to scale. Great care will have to be taken in reading your angles, otherwise when you come to the drawing you will find that the figure does not close, but leaves a gap. Note that all the interior angles added together, plus four right angles, will be equal to twice as many right angles as the figure has sides. Try if this be so with your results. Fig. 13 shows the survey of a village.

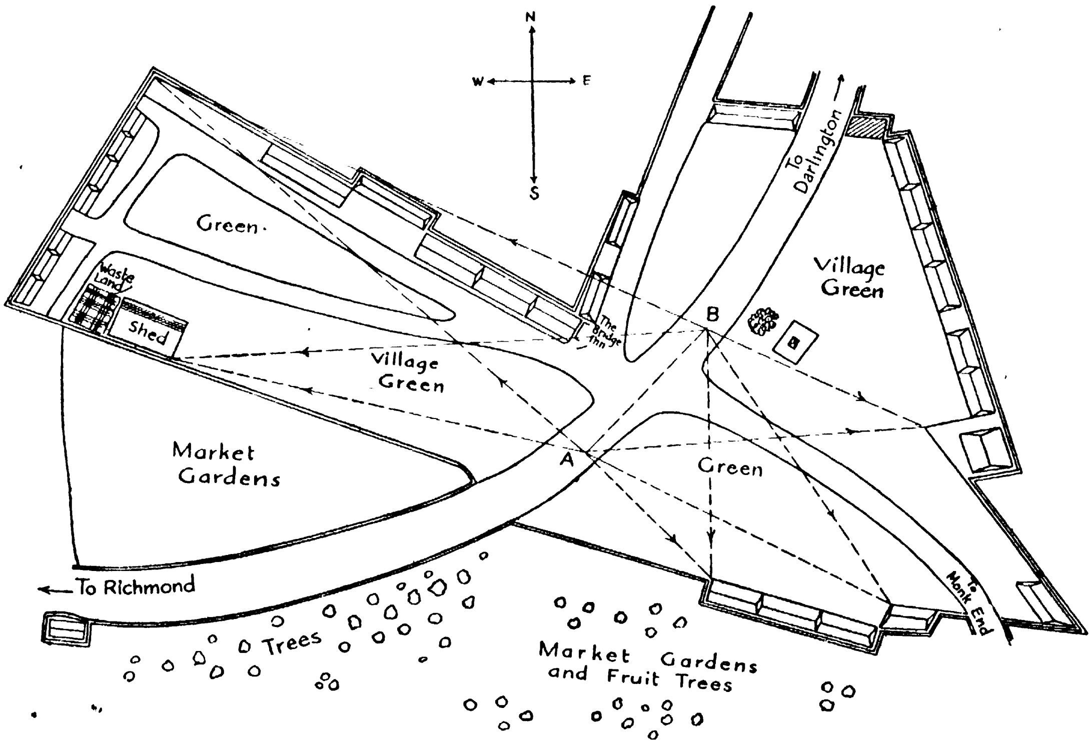

N
W
E
S
To Darlington
Green
Village Green
Waste Land
Shed
The Bridge Inn
B
Village Green
Market Gardens
A
Green
To Richmond
Trees
Market Gardens and Fruit Trees
To Monk End

Fig. 13

House Survey.—This little piece of work is one of the most interesting in the whole of surveying. Look at fig. 14. You get a *base line* A B parallel to the gable end. This is done with tape and ranging poles. Measure its distance from the wall and record it.

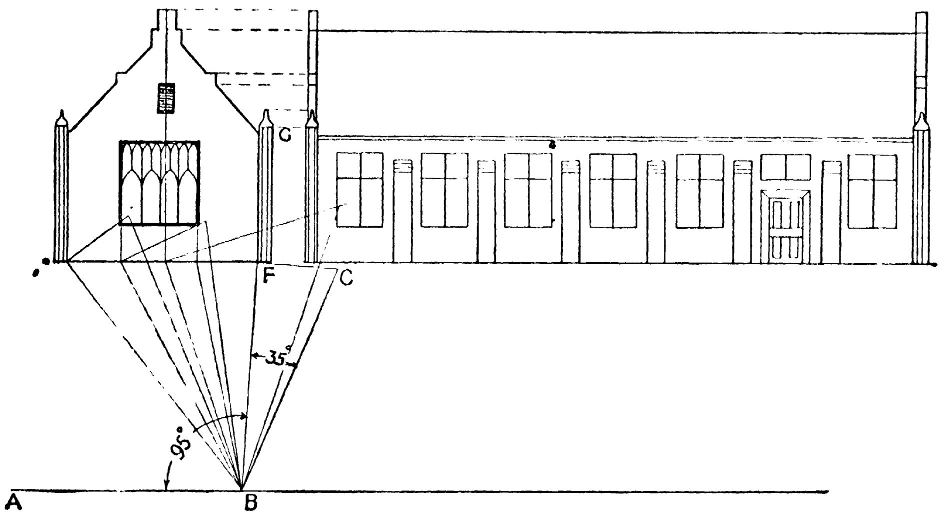


Fig. 14

Next fix your theodolite at B, so that the sighter lies along A B, and suppose the angle shown by the index on the horizontal scale = 0°. Next swivel the sighter round so as to come to the end wall, and read the angle = 95°. It is best to draw a rough freehand sketch of the gable end in your notebook, and mark the angle carefully. Next turn the sighter so as to

move in a vertical plane to reach the top of the wall, and read the angle again = 35° say. Now proceed in this way for every point—window, doors, roof, chimney-pots, &c. You will thus see that from B there is a goodly number of angles to be drawn. Hence, in order to simplify matters, you can go to point A, and do the other half of the gable end from that point. Measure from A to B and record it. In the actual setting out in your classroom, after your observations

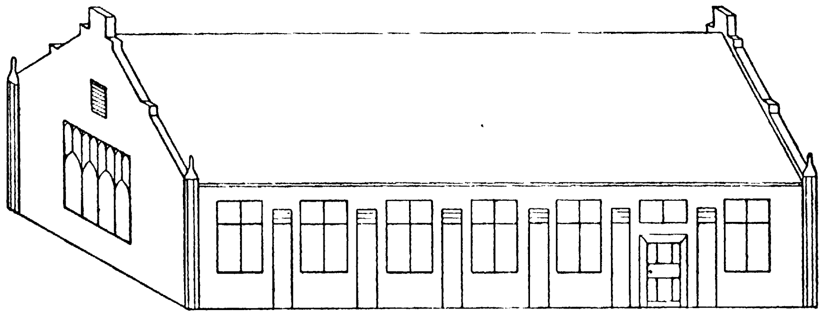


Fig. 15

are finished, choose some scale and start from B. Make A B F = 95°. From F erect a perpendicular F C. Then at B make an angle F B C = 35°, which is the elevation of the top of the wall. Then F C *plus the height of your theodolite* above the ground will give you the height of the wall F G. Repeat this process for other points, and ultimately you will get the gable end as shown in elevation in the drawing. Continue for the long side of the building along its base line and you have the figure as shown. Perhaps it will be better to start with a simple house first, as the one in the figure is of ornamental terra cotta and rather difficult.

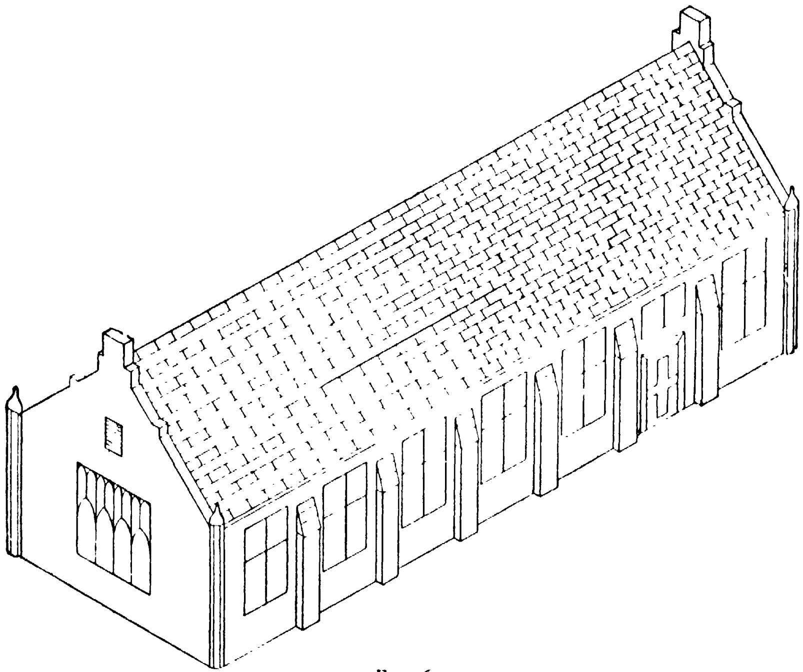


Fig. 16

The boys who did this survey had previous experience, and were of ages fourteen to sixteen years. In fig. 15 we have the combination of the two views to make an ordinary *oblique projection.* In fig. 16 you have the combination of the two views for an isometric

projection. Notice the lack of perspective here, and compare it with what any photograph of the same would be like.

Measuring Heights and Distances:—

(i) *By Plotting:*

A C = tower; B = theodolite; θ = observed angle.

Measure B C = x feet.

Draw out to scale and find A C.

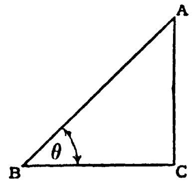


Fig. 17

(ii) *By Mathematics, for hill with no base point:*

(i) .... $\dfrac{AC}{x+20} = \tan 30^\circ$; and $\dfrac{AC}{x} = \tan 33^\circ$

Hence $x = \dfrac{AC}{\tan 33}$

$\therefore$ Substituting in (i) we get

$$\frac{AC}{\left\{\dfrac{AC}{\tan 33} + 20\right\}} = \tan 30^\circ$$

From which A C may be calculated.

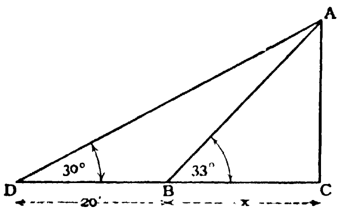


Fig. 18

CHAPTER IV

Contouring (Map-making)

Preliminary Notions.—To give boys some introductory notions on contours, the following has been found very useful:—Put a mound of clay into a water-tight box, as shown in fig. 19. Place at the bottom of the box a sheet of oiled paper. Fill the box with water up to, say, 2 inches from the base, and then with a long hatpin prick through the water line at numerous points; the more the better. Repeat this process for a level of 4 inches from the bottom, and so on till the top is reached. Remove the clay and draw out the oiled paper, and transfer the markings to a sheet of drawing paper. Complete the pricked contours, and let boys observe that in steep places the contour lines are crowded together, and in places of slight slope the lines are wider apart. If this idea is once implanted, there will be no trouble later when they undertake more difficult work in the country survey.

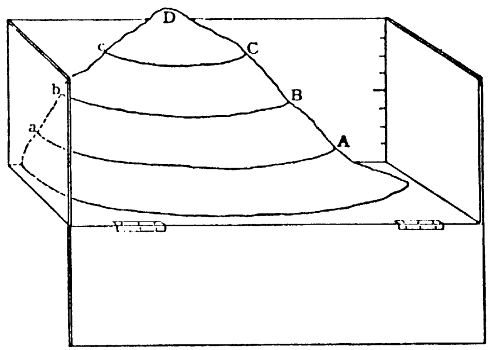


Fig. 19

Sectioning.—Start the process again, and pour in water to a depth of 2 inches. Put into the clay two long hatpins at A and *a* where the water line reaches. Pour in another 2 inches, and put in two pins at B and *b*; similarly for C and *c*, and at D. These points should all be on the same vertical plane. Now lay a long metre measure or a ruler across the top of the box in a line with the pins, and read off the *horizontal* distances of *a*, *b*, *c*,

D, C, B, and A from one side of the box. Record these distances. Then take some squared paper, and with these distances as horizontal ordinates and 2-inch rises, plot a section for plane passing through *a*, *b*, *c*, D, C, B, and A. When this has been done, take string or a long carving knife and cut the mound into two pieces through these points, and you have the same shape as the one plotted. This has been tried in the chemistry laboratory with boys, and they are not only highly interested, but they get a first-hand knowledge of what a contour line really is.

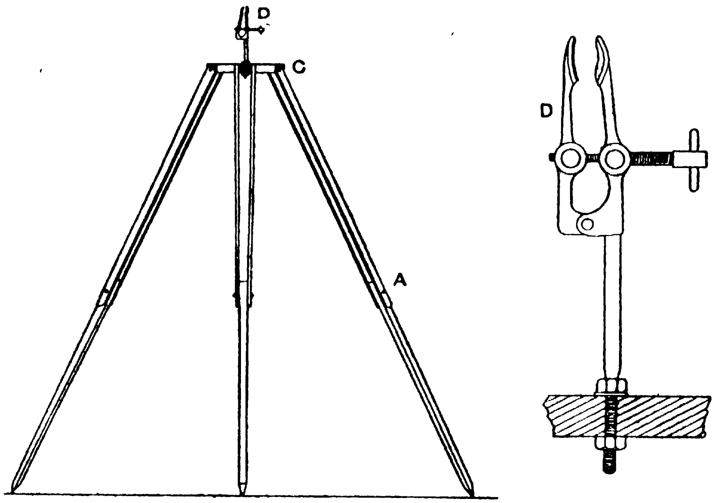


Fig. 20

The Level.—In professional surveying a level is an expensive article, costing £30 or £40. A simple one, which can be made very cheaply, is illustrated in fig. 20. It consists of a tripod A, such as is made for the theodolite; C is a circular disc, and D an ordinary clamp off a retort stand from the chemistry room. The clamp is screwed and fitted with two nuts and a washer. A hole is bored in C to receive D, and thus by using the nuts and washer we get a rigid support for it. Below is given a simple method of making a telescope. The only other things required are two spirit levels. These can be made, or

they may be bought cheaply. One spirit level is for the top of C, and the other is for the telescope barrel. Notice that no graduation marks are needed—the telescope being horizontal—hence the name **level.**

The Making of the Telescope. Secure two lenses, one of, say, 10-inch focus, and the other of, say, 1-inch focus. To find the focal length, hold the lens to face the sun, and a bright spot can be thrown on to the wall. (Try it on the back of your hand.) When this image is clear, measure the distance from the wall to the lens; this is the focal length. Repeat with the other lens of, say, 1-inch focus.

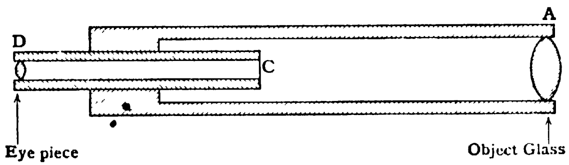


Fig. 21

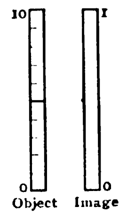


Fig. 22

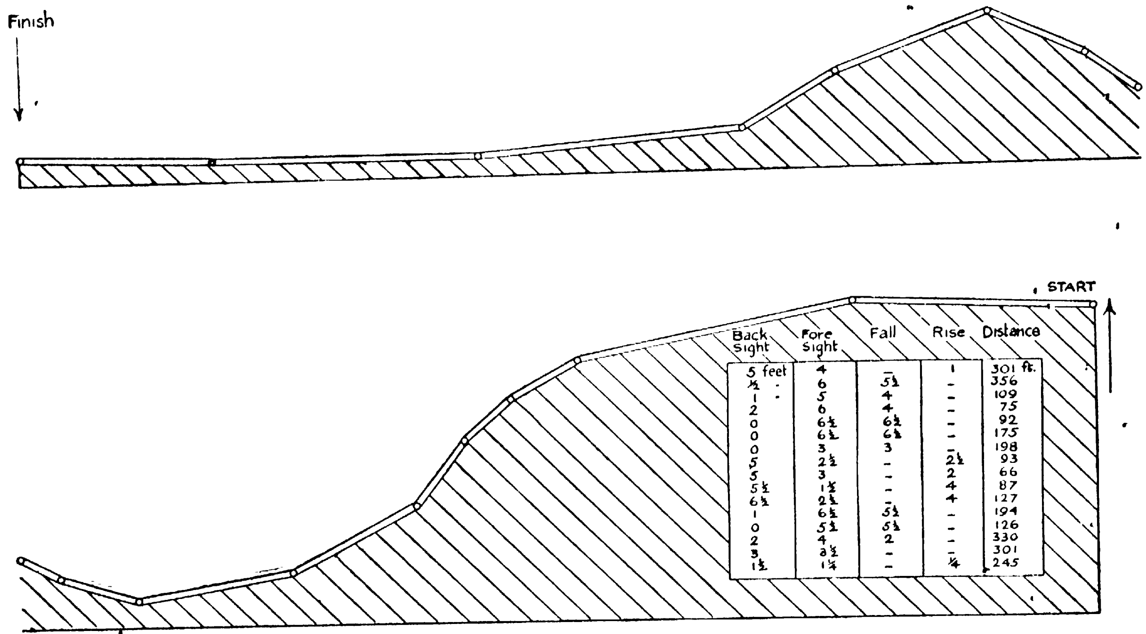
Now make a cylinder of cardboard or tin, and fix the 10-inch lens into a circular piece of wood and place it to fit tightly into the end of the barrel, as at A in fig. 21. This is called the object glass. Now place the eyepiece D in a wooden shell, and fix it in a smaller cylinder of cardboard, as in figure. The end C has two cross wires. Move the eyepiece in and out till a clear image of some object is seen on looking into D. You will get an inverted image, and will also find that the distance DA is about 11 inches in length.

Now open both eyes, and with one look at the image through the telescope and with the other at the object direct. They should appear alongside one another. If the object you are observing be a ruler, you can easily calculate the magnification (fig. 22).

$$\frac{\text{image}}{\text{object}} = \frac{10}{1}$$

$$\therefore \text{ magnification} = 10$$

This is very difficult to do at first, but after a little practice and perseverance you will see how easy it becomes, and how very useful it is in finding magnifying power.



Back Sight	Fore Sight	Fall	Rise	Distance
5 feet	4	–	1	301 ft.
½	6	5½	–	356
1	5	4	–	109
2	6	4	–	75
0	6½	6½	–	92
0	6½	6½	–	175
0	3	3	–	198
5	2½	–	2½	93
5	3	–	2	66
5½	1½	–	4	87
6½	2½	–	4	127
1	6½	5½	–	194
0	5½	5½	–	126
2	4	2	–	330
3	2½	–	–	301
1½	1¼	–	¼	245

Fig. 23

Levelling a Road.—Examine fig. 23. This was done by boys about thirteen years of age. Take the first two small circles. At the first one, marked **start,** a boy holds up a

levelling staff, a rod marked in feet and inches, about 10 feet high (you can easily make one in the manual shop). The telescope is turned and focused on the staff, and also tried with the levels to see if horizontal. The reading on the staff, which coincides with the horizontal cross wire, is recorded. It is 5 feet, and is called a **back sight**. Next the staff man goes to the second circle shown on diagram, and measures his distance walked—301 feet. Here he puts up his staff, and the telescope boy again sights him after carefully fixing his level. This reading is 4 feet, and is called a **fore sight**. Hence the rise is 1 foot, as will be seen from the diagram.

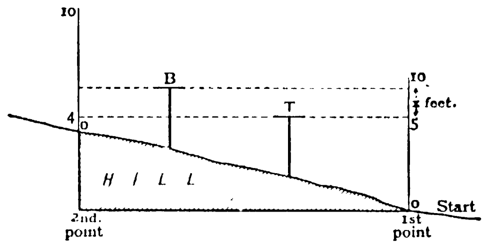


Fig. 24

Notice that the staff is marked as it is seen on looking through the telescope, O at the bottom. Professional surveyors will possibly tell you something about the figures on the "levelling staff" they use, but remember that amateurs should not attempt too much at once. Some smart boy will perhaps ask if it makes any difference where we have the telescope. Try it and see. Place it at B, as in fig. 24. Now you see that figure 4 has been increased by x feet, hence the reading is $(4 + x)$ feet; similarly the other reading is $(5 + x)$; but $(5 + x) - (4 + x)$ still gives you 1 foot, therefore the position of the telescope is immaterial so long as you take the distances between the two places where the staff is placed. The drawing is self-explanatory if taken in conjunction with the readings. Notice, however, that the distances walked are in the section represented as sloping lines where there is a rise or a fall, and by horizontal lines where there is *level* road. Choose a suitable scale, and finish your drawing as in figure.

Contouring a Hill (for drops of 5 feet).—This is best done with the **clinometer**

(fig. 25). It consists of a semicircular piece of wood with a graduated scale fixed to it. A is a thin metal pointer hung on a pin, so as to swing easily with the slightest movement of the wooden base when held in the vertical plane. B is a metal tube (an old gas pipe

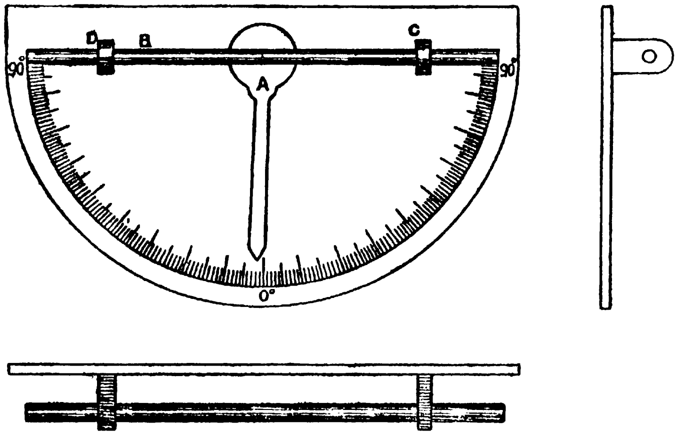


Fig. 25

will do) fixed firmly into two supports, C and D. If D C is tilted slightly, the pointer moves through the same angular distance.

Now look at the contour of the hill (fig. 26). At the point C a boy stands with his clinometer and sights a ranging pole placed at Y lower down the slope. This is usually placed at the end of the first uniform slope on the hill. He sights a point previously marked on the pole, at the same height as his own eye is above the ground, when standing

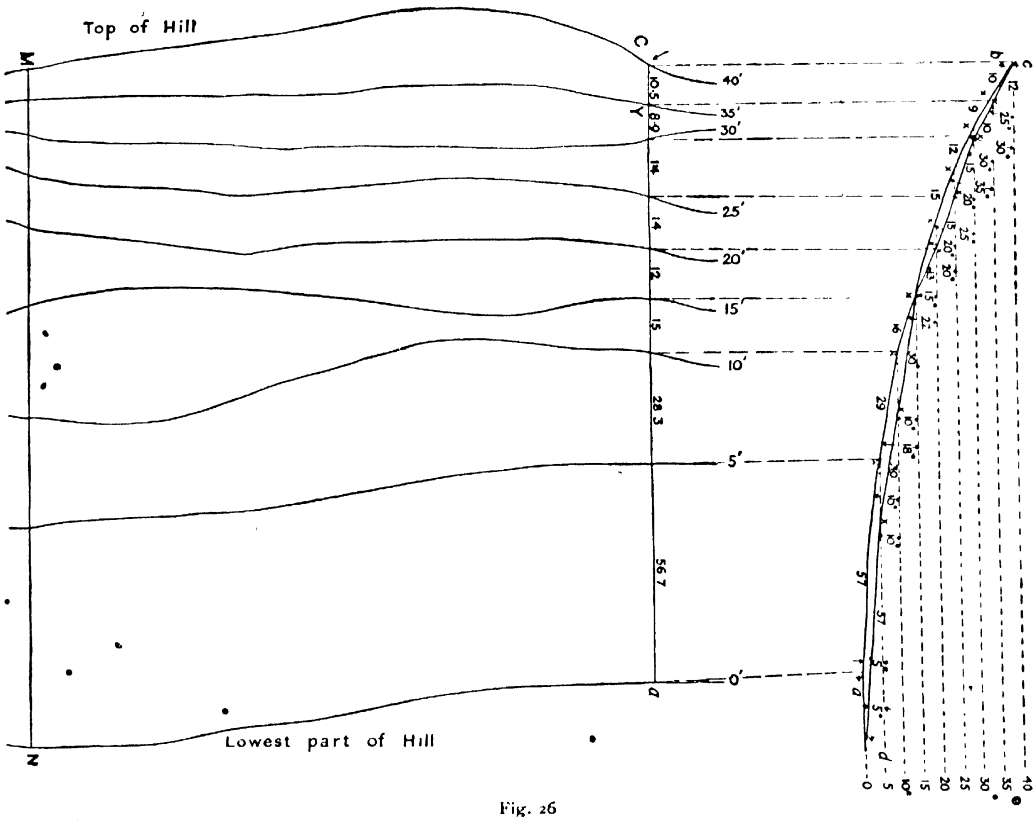


Fig. 26

on a perfectly level piece. The angle is read off. Then he calculates how far he has to walk down the slope for a vertical drop of 5 feet with this angle of depression he has obtained, say 25°.

For boys who have some knowledge of elementary trigonometry the following calculations will be easy:—

$$\frac{BQ}{CQ} = \sin 25^\circ \therefore CQ = 11.8 \text{ feet, say 12 feet approximately;}$$

$$\text{and } \frac{BC}{CQ} = \cos 25^\circ \therefore BC = 10.5 \text{ feet approximately.}$$

If the boys do not know elementary trigonometry, it is easy for them to plot the results graphically and find B C and C Q in this way.

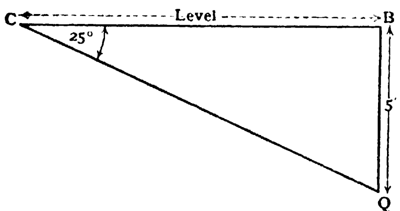


Fig. 26 *a*

Having made their observation, the boys advance down the hill, the pole man going lower down the slope and the clinometer man walking after him a distance C Q = 12 feet about. Here he stands with sketch book in hand, and faces round the way he has come, and looks to right and left. He then sketches the general contour on both sides of him in his book. If steep, his contour lines rise to the top of the hill, and if *not* steep then his contours fall away from the top, for where the contour lines on a map are closely packed together we know that here the hill is very steep. Having done this, he faces round and again sights the pole, reads another angle, calculates how far to walk for a drop of 5 feet, and repeats his cycle of operations. This goes on till he reaches the bottom. A great saving will be effected if he has a previously prepared sheet like the following:—

	Angle.	Horizontal Distance.	Sloping Distance.	Vertical Drop.
Approximately	1°	286.4	286.6	5 feet
	2°	143·1	143·2	5 ,,
	3°	95·4	95·6	5 ,,
	4°	71·5	71·7	5 ,,
	5°	57·2	57·3	5 ,,
	6°	47·5	47·8	5 ,,
	7°	40·7	41·01	5 ,,
	&c.			
	25°	10.5′	11.8′	5 ,,
	&c.			

Another line M N on the diagram is ranged similarly, and so on till the whole hill, or one face of it, is finished. Then the contours are drawn out as shown.

Of course, if you are doing a mountain with large drops, your table above will have to be previously prepared for, say, 30-feet or 50-feet drops.

Another Useful "Level" is shown in fig. 27. It consists of a wooden support and an ordinary **U**-tube arrangement of glass, filled with some coloured liquid: the longer the limb between A and B the better. This level can be used for short distances on a road, and it depends for its accuracy upon the fact that water *finds its own level*, so whatever angle the wooden stand makes with the road the top of the water in A will be in a line with the top of that in B. Hence we can sight three points all in one line. It really takes the part of a telescope without the magnification.

Relief Map.—Secure a 6-inch Ordnance map. Take a section A B C D as in fig. 28. Divide A D into quarter inches and draw horizontal lines across, as *ay*, *bz*, &c. Let a boy take a sheet of drawing paper and lay it along *ay*, and mark on it all the points

where it cuts the contour lines. Then allow him to erect on this base line a section of the district, as seen at *ay* in front elevation as in fig. 29. Now cut out a piece of stiff cardboard the same shape as this, and on it place a layer of grey clay $\frac{1}{4}$ inch thick the exact shape of the section.

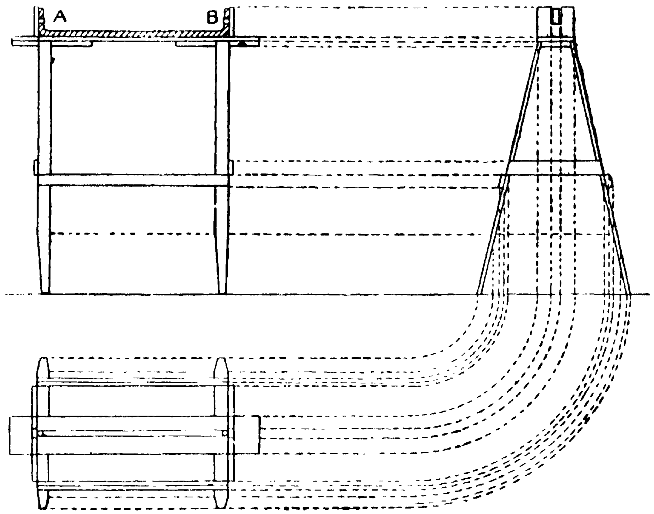


Fig. 27

Repeat this process for every quarter inch of the map and we get a series of "layers" of clay. It is best to number these (1), (2), (3), and so on, in order not to get them confused. Now place them together in order and surround with pieces of wood to press them gently together along their length. Round off carefully any eccentricities which are sure to have arisen, and we have a clay relief map. Next take your model and build round it with wood to about 4 inches above the highest point. Take some boiled oil and give the clay two or three coats of this, allowing it to dry in. This is to avoid sticking when we take a cast. Pour on to the top of the clay, after the oil has dried, some plaster of Paris of proper consistency and allow it to set hard. When ready remove it, and we have a plaster of Paris negative. Take this and coat well with oil again, and from it take a positive in pretty much the same fashion as before. This

should be a very good relief map of the district chosen. The boys can now buy penny tubes of paint and paint it, showing towns, villages, rivers, &c.

Note.—It is found that preparatory to the above exercise it is a good exercise to take the hectograph and print off some imaginary maps with easy contours, and allow boys to make sections of these first before tackling real Ordnance maps. Then let them turn up in their atlases some country which is contour-coloured, and from these make easy sections. Then when they are able to do this, satisfactorily they can proceed to the making of the actual model described above.

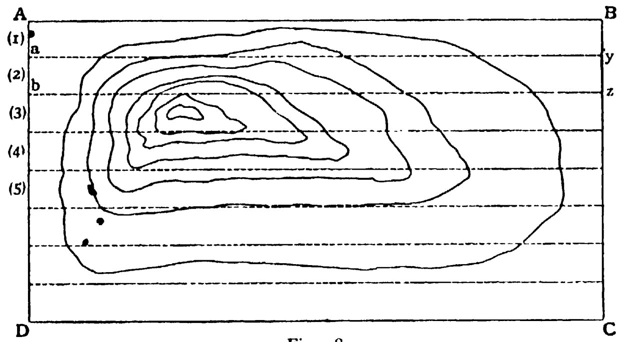


Fig. 28

Fig. 29

Other Maps.—Another useful exercise consists in letting the boys trace on tracing paper the contour lines from an easy map in their atlases. Then transfer these shapes to fretwood. Cut out these shapes and glue together to form a "layer" relief map. The only objection to this is that there are perpendicular drops from one layer to another. Fill these drops in with putty, and a very good map is the result. This can be coloured as in the first method.

A good deal of useful knowledge is gained in the course of these processes regarding (i) plaster of Paris; (ii) putty sticking to wood unpainted, and so on.

CHAPTER V

Prismatic Compass Survey

The Compass.—A prismatic compass is rather expensive—a good one costing from two guineas upwards. Hence to save expense it is necessary to devise some suitable substitute. A simple and reliable one is shown in fig. 30. This consists of an ordinary wooden box with two uprights, A and B, through which are bored two round holes fitted with cross wires. C is a piece of plain mirror silvered on the back, with a clear portion scraped as shown, and inclined at 45° to the lid of the box, then fitted to the bevel on the top of the upright B. In the base of the box is a compass needle (reliable and strong) which is fixed to a circular disc of stiff paper graduated from 0°–360°. The needle moves and is pivoted upon an upright pin passing through the box base. In this we have a satisfactory substitute for the prismatic compass. In fact, if the mirror were replaced by a 45° prism of glass blackened on the back, we should have the complete two-guinea compass as sold by scientific instrument makers. The N pole of the needle is fixed under 180°. It is better and more stable if the apparatus is placed on an ordinary photographic tripod fitted with a circular top. The needle comes to rest more quickly in this way.

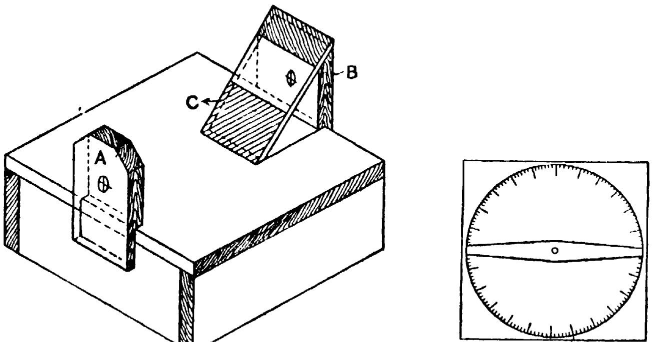
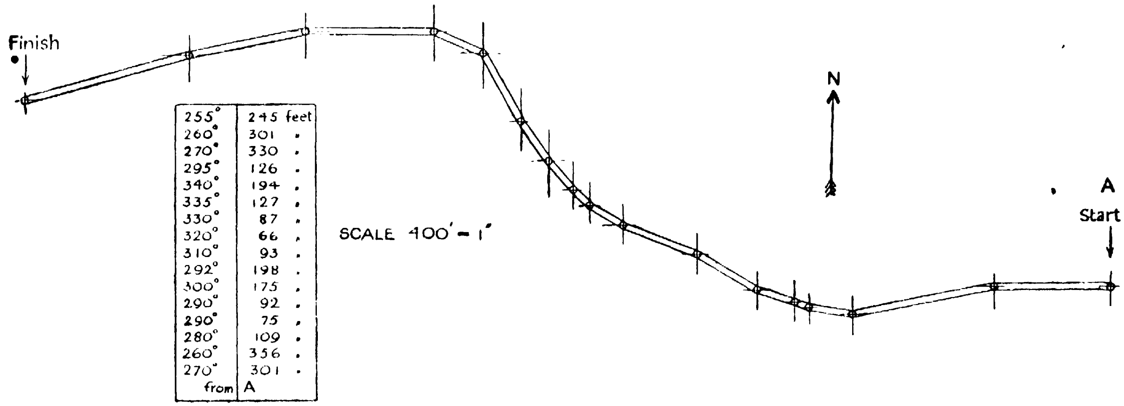


Fig. 30

Method for Traversing a Road.—Look at fig. 31. This shows a road which has been surveyed. Take the point where it says *start*. At the first two small circles, poles have been set up. One boy, standing at the first, sights the second pole, and gets the angle 270°; the distance is also chained off, and we find it to be 301 feet. Enter the results as shown in the



255°	245 feet
260°	301 "
270°	330 "
295°	126 "
340°	194 "
335°	127 "
330°	87 "
320°	66 "
310°	93 "
292°	198 "
300°	175 "
290°	92 "
290°	75 "
280°	109 "
260°	356 "
270°	301 "
from	A

Fig. 31

field book, and proceed in this way from pole to pole. It is best to arrange your poles at the end of each long piece of straight road as far as the eye can reach. The results should be drawn out as shown, the points of the compass indicated, and the scale placed on your drawing. Any houses, or rivers, or bridges, &c., may be shown, thus adding to the completeness of your work. A good set of drawing instruments is of great assistance in making the drawings. Please notice that in the drawing your angles are plotted out from the north *by the right*. An examination of your circular disc and its movements with the needle when

in use will make this quite evident to you. The course of a river is a very interesting exercise for this work, and in conjunction with it the width of the river may be measured, as explained in Chapter I on "Chaining".

A Traverse Survey.—Suppose we wish to find the area of a large lake, or pond, or a field with a dense wood in it, or a bog, for instance, then this method commends itself to us, for we could not very well chain across these things. (See fig. 12, p. 175.) Arrange poles at A B C, &c. You will notice that by suitable selection of your points round the pond, parts of it lie within the straight line and parts outside. Now, by taking a sufficient number of points the overlaps can be made equal to the omissions, hence a balance will be maintained.

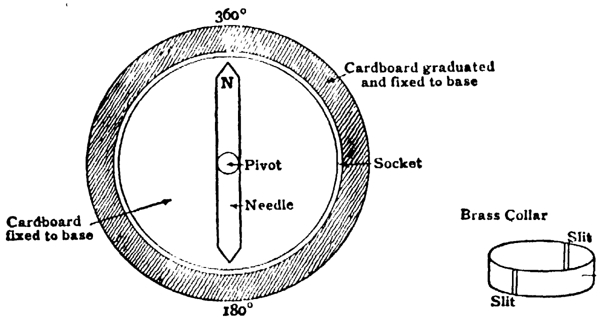


Fig. 32

Start, say from B, and sight C and A—the angles read will give the ones indicated on the diagram. Proceed in this way round the figure and chain off your distances. Then when the figure is drawn the area can be calculated by any formula or method you have learnt in your mensuration. The position of an island or boathouse may be suitably located and drawn in.

Another form of Compass is that in which the needle is not fixed to the circular disc, but swivels round quite alone on its pivot. Examine fig. 32. Arrange the graduations so that N pole points to 360° or 0° when at rest. Into the socket fits a collar of brass or cardboard with two vertical slits directly opposite one another, as shown in diagram. When

in use bring the needle to rest with the two slits in a line with it, and hence in a line with 360° and 180°. Then, when quite steady, move round the collar so as to sight some distant object through the slits, and thus get the magnetic bearing from true North either round

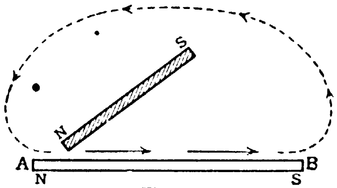


Fig. 33

from the right or left as the case may be.

For boys interested in the making of the needle, the following brief notes and diagrams are given:—

Magnetization.—(i) *Single Touch.* AB in fig. 33 is your strip of steel to be magnetized, and the other is a permanent magnet, which can be obtained at any penny bazaar.

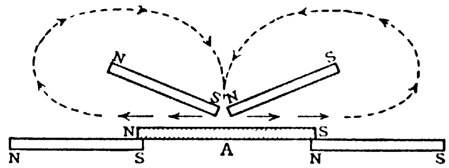


Fig. 34

(ii) *Divided Touch.*—The strip A, in fig. 34, is your steel spring placed upon two permanent magnets. A is then stroked by two other permanent magnets in the direction shown. The resulting polarity is shown.

Of course you could buy a small needle to pivot without all this bother, but there is far more virtue in designing and constructing your own.

CHAPTER VI

Measuring the Earth's Circumference

The Altitude of Pole Star is equal to the Latitude of the Place.—See fig. Let E be the place of observation, say latitude 50° N. F D is the horizon at that place, E Y is the direction of the pole star, also A X is the direction of the pole star at the north pole A. These two are parallel, on account of the great distance of the star from the places of observation. The angle F E Y is the altitude or angle of elevation of the pole star, and easily be found with the theodolite any clear night.

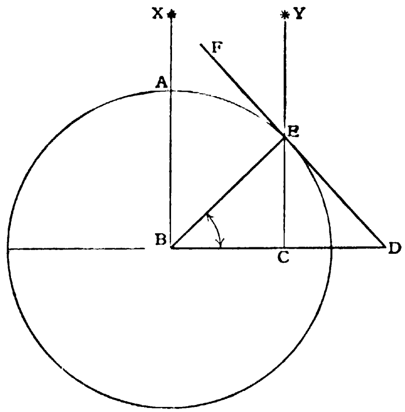


Fig. 35

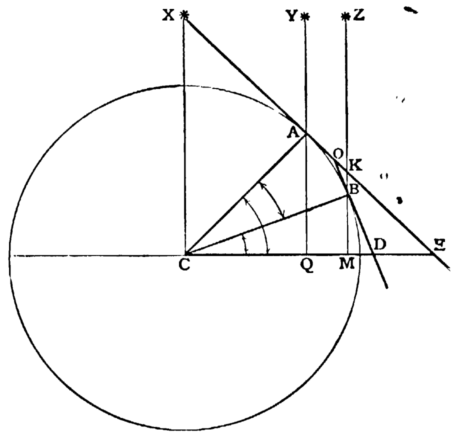


Fig. 36

Angle F E Y = C E D = E B C = latitude 50°.

If the geometry is not understood, make a paper duplicate of the drawing, and by cutting out you will find that the above is true.

Hence altitude of pole star = latitude of the place of observation.

The Difference in the Altitude of the Pole Star as measured from Two Places on the Earth's Circumference, *on same meridian*, is equal to the Difference in the Latitudes of these Two Places.

See fig. 36. Let A and B be the two places of observation. E A X is the horizon at the place A; D B O is the horizon at the place B.

Now, as above, Q A E equals the latitude of A and M B D or O B Z is the latitude of place B.

Now, Q A E = A K Z; and the difference between A K Z and O B Z is B O K. But B O K = B C A; hence the difference in the latitude equals the difference in the altitude of the pole star.

This geometry may be difficult to most boys of tender years, but if the diagram is cut out and measured the truth of the statement will be verified.

Application of the Above.—Let one of the boys at a town in the north of England get into communication with a schoolboy in a town at the south of England, *on the same meridian*, and if they compare their altitudes on any particular occasion, they can find the difference in latitude. Hence if they calculate the mileage between the two places by an examination of the railway fare (one penny a mile), they can calculate the distance round the earth to within a reasonable approximation.

OTHER MODELS AND THEIR USES IN TEACHING PRACTICAL GEOGRAPHY AND SURVEYING

Height Finder.—In fig. 37 we have a useful model of an instrument made in wood which can be used in place of the theodolite. It forms a very good exercise in the manual room in the making of *joints*.

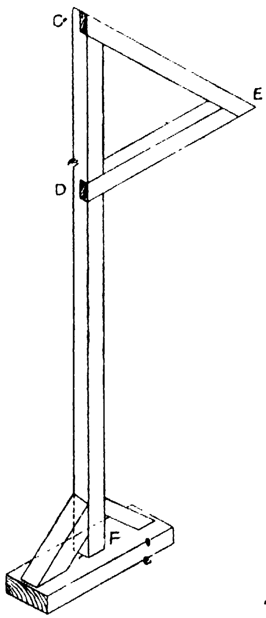


Fig. 37

Fig. 38, B A is supposed to be the gable end of the school. Arrange the finder so that on looking along E C you can just see A. Then B A is equal to B F plus the height F C.

$$\text{For } BAG = 45^\circ;\ \text{hence } BA = BG = BF + FG;$$
$$\text{Also } FG = FC,$$
$$\therefore BA = BF + FC.$$

The chief points in the gable end can be found and a drawing to scale made, as was done in the case of the theodolite. Oblique and isometric projections may follow in due course as there indicated.

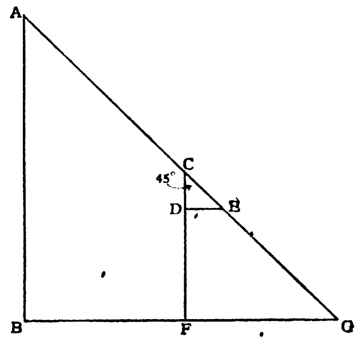


Fig. 38

The Sextant is an expensive piece of apparatus to buy, but the one shown in fig. 39 costs about *2d.* and gives quite good results. The framework is cut out of fretwood, and the

slider B is riveted loosely at A. X and Y are two pieces of plane mirror, fixed as shown, X being made to point to 0° for the initial position, and Y parallel to it. Z is simply a piece of red glass, and takes the place of the telescope in the more expensive instrument. The degrees are numbered twice the actual size of the angle. For elevations, bring A to zero and focus on some point by looking through Z in a straight line through the clear portion of Y. Then when the pointer is moved along you get the image of some other distant object to coincide with the object seen by direct vision. Read the angle and you have the angle subtended at the eye by the two objects. The same exercises mentioned under the heading "Theodolite", p. 175, can here be repeated and drawings completed. The theory of the sextant can be seen in any textbook on light. It depends upon the fact that if a ray of light is incident upon a mirror we get a certain reflected ray.

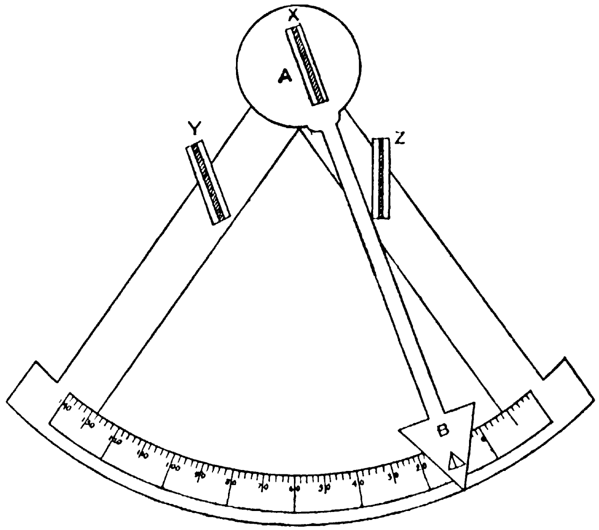
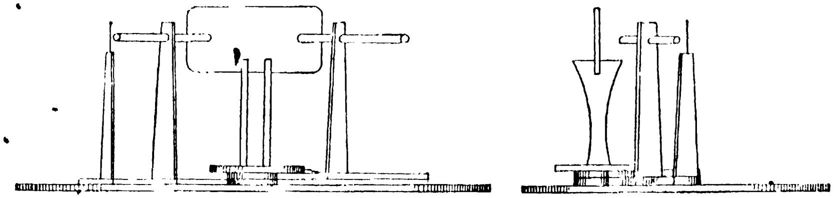


Fig. 39

Now, if we move this mirror slightly through an angle, then the reflected ray moves through twice the angle that the mirror has moved through. Fig. 40 illustrates this fact. *abc* is a small semicircular piece of wood which carries the mirror, and it can be moved through a small angle. XY and ZO are tubes pointing to the mirror, along which the observer



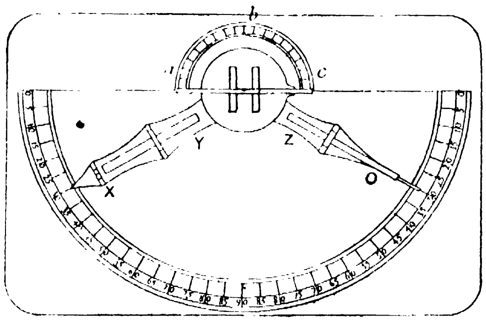


Fig. 40

looks. By placing pins in the proper position we get a certain reflected ray, obeying the laws of reflection in light. Now keeping XY fixed and moving *abc* slightly, say 5°, we have to move the arm ZO through 10° in order to bring the pin at O once more into view.

The Anglemeter forms another useful piece of apparatus for surveying. This is a somewhat cheaper form of sextant.

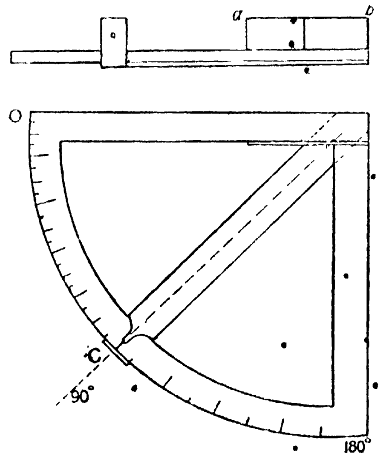


Fig. 41

In the diagram (fig. 41), *ab* is the plane mirror, C the sighter. Note that the angles are marked double degrees. The anglemeter can be used to find the angle between two converging lines thus:

Suppose we wish to find the angle between DC and CA in fig. 42—that is, between two corners of a room A and D and the observer, who is sighting through F, but who is

supposed to be at C—bring image of A in the mirror into coincidence with the point D seen over the top of the mirror.

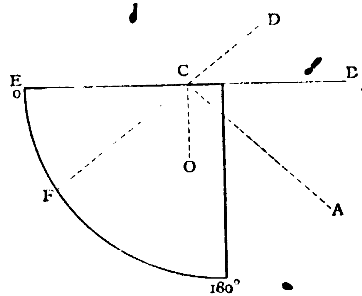


Fig. 42

Then angle A C O = O C F,

∴ remainder B C A = remainder E C F.

But E C F = B C D.

Hence D C A is double the angle E C F.

Hence by sighting at F we get on the instrument the angle E C F to be the angle required, but this must be marked with double degrees for reasons stated.

This little model lends itself easily to construction in either wood or metal.

Length of Day and Night Apparatus.—In any textbooks on physiography you may find the following statements proved:—

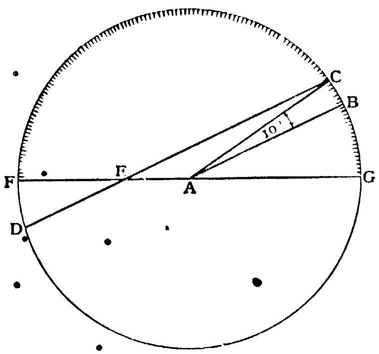


Fig. 43

(i) With sun north of the equator, the latitude of a place is the complement of the sun's altitude plus the northern declination.

(ii) With the sun south of the equator, the latitude of a place is the complement of the sun's altitude minus the declination.

(iii) At the equinoxes the sun's altitude is the complement of the latitude.

G B C F D (fig. 43) is a circular piece of cardboard graduated in degrees.

A B is a cardboard link movable about A. A C is a cardboard link movable about A also, and fastened by a small pin to the arm D C.

Point A B to the altitude of the sun at the equinoxes. That is, G A B equals the complement of the latitude. Find the sun's northern declination on the day in question, and suppose it to be 10°. Make the angle B A C = 10° and set A C to this angle. Now move the link C D parallel to A B, and C D will represent the path of the sun in the heavens on this day.

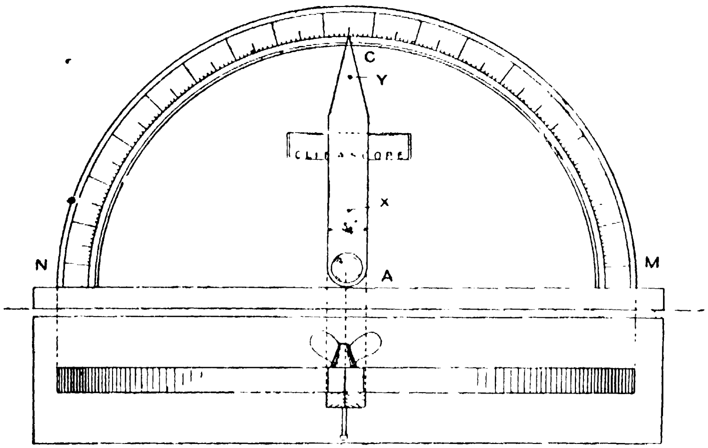


Fig. 44

Hence $\frac{EC}{DC}$ is the fraction of daylight, and $\frac{ED}{DC}$ is the fraction of dark. Measure these, and suppose E C = 5 units and D C = 8 units.

Hence $\frac{5}{8}$ of 24 hours = 15 hours
and $\frac{3}{8}$ of 24 ,, = 9 ,,
Again, 15 hours ÷ 2 = $7\frac{1}{2}$,,

So, by taking $7\frac{1}{2}$ hours on each side approximately of 12 noon, we arrive at sunrise and sunset. Of course, to be more exact, we must consider the *equation of time*.

Finding the Sun's Altitude.—Look at fig. 44. The apparatus is made of wood. It has a movable pointer A C, in which are two nails X and Y projecting. Place on a plane-table with M N horizontal, and move the pointer towards the sun. When the two shadows cast by the two nails are coincident, you know that the true angle of elevation is obtained,

Repeat this for different days of the year, and plot results. From the resulting curve you can find the date of the lowest point reached or the elevation of the sun on the shortest day, &c.

By means of a long stick, fixed vertically with plumb-line, you can also get the angular elevation. Plot results and measure the angle. This forms a useful lesson for boys just starting outdoor work.

Finding the Latitude by an Observation of the Sun's Altitude.—The apparatus consists of a semicircular piece of wood (fig. 45), with a movable pointer A C, swinging on a pin at C′. Attached to C′ is another pointer C′X. This can be cut out in tin, and is shorter than A C. In the pointer A C are two nails *a* and *b*. To use the apparatus, commence with M N horizontal and A C vertical, so that C is over 0°. Also find from tables in *Whitaker's Almanac* the sun's northern or southern declination on the day in question = 10° say. Move the pointer C′X so as to make 10° with the pointer A C. Then move A C so as to get the sun's altitude by getting shadows cast by the two nails to be coincident on the horizontal board *pqr*. The angle to which C′X points gives the latitude, which, as stated above, is given by the following:—

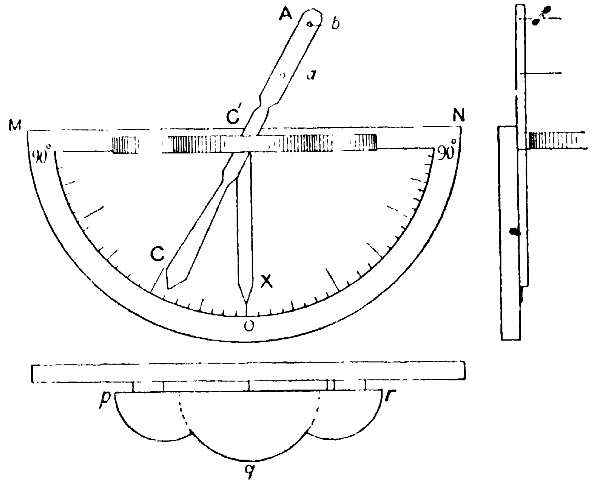


Fig. 45

Latitude = Complement of sun's altitude ± declination.

This piece of apparatus was designed by a boy fourteen years of age after he had been given the theory lesson on the relationship of latitude to altitude and declination.

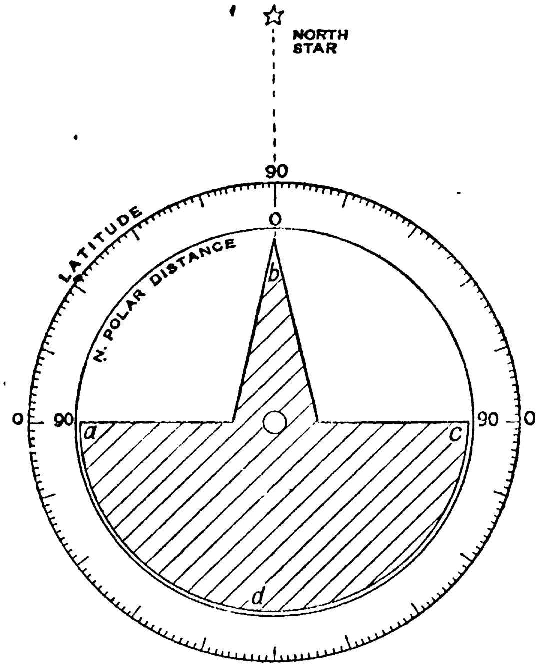


Fig. 46

Latitude and Polaris—Finding the Latitude by Observations of Pole Star.—Take a circle of cardboard and mark on it two concentric circles, as in fig. 46. Fasten by a pin at O to a sheet of thicker cardboard to act as a base, and mark the position of the north star. Cut out a shape *a b c d* in cardboard and pin it on at O to the circular disc. Turn circle round so that 90° and 0° are on a line with the north star, and turn pointer *b* to the pole star also. Now suppose the place of observation has a latitude 50°, then turn *b* to point to 50° latitude. In this position *ac* will become equivalent to a horizon, and the angular distance between *a* or *c* and the pole star when in this position gives the altitude of the star for that latitude, and is read off on the inner circle. Many suitable exercises can be framed on this for boys to work out from their atlases.

Model for the Seasons.—This is a useful model (fig. 47). The globes are made from ping-pong balls, mounted in wood supports, with their axes in the proper direction. The

lines of latitude are marked on the balls. These are all placed on a board, in the position shown in fig. 48, with a ball at the centre for the sun. No amount of drawing on the blackboard will make the lesson as realistic as this model does. The boys see that at

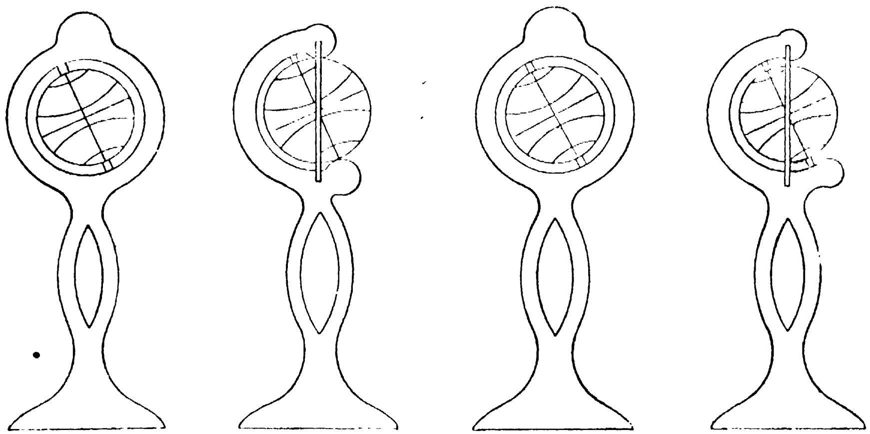


Fig. 47

(1) and (3) there is one-half of each line of latitude in the light and one-half in the dark *all over the world*, and that in (2) and (4), on account of the constant inclination of the axis, there are unequal portions within and without the zone of light. They also realize the idea of northern and southern declination by observing positions (2) and (4).

Model to Show Phases of the Moon. -Draw an octagon on a piece of cardboard as

at *abcdefgh* in fig. 49. Surround this by a great circle, and at each line of the octagon erect a piece of plane mirror about 2 inches high. Fasten these mirrors together at their junctions, and you have an octagonal mirror. Now round the larger circle shown, place at equal intervals small ping-pong balls, mounted in wooden stirrups to rest on the larger board. Be careful to see that the

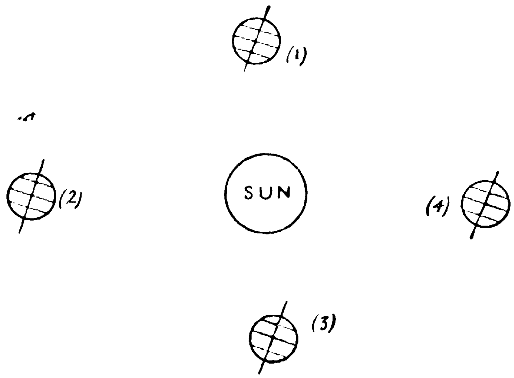


Fig. 48

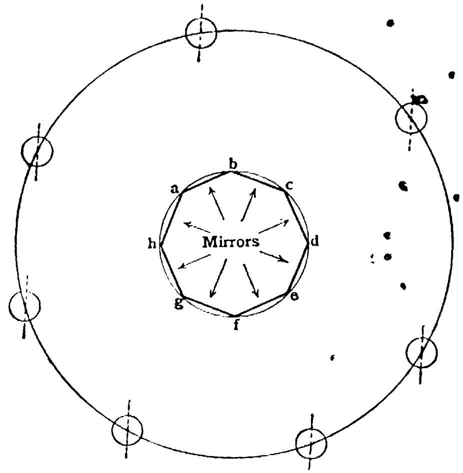


Fig. 49

great circle on each ball always points in one direction. Look into the mirror and walk round the outside of the figure and you see each phase of the moon—from new to full, and so on. You can so arrange that you stand still and the balls rotate, when you will still have the same effect. The boys will see at once that the moon only rotates once on its axis in its movement round the earth. Hence we always *see* the *same* side of the moon on our earth.

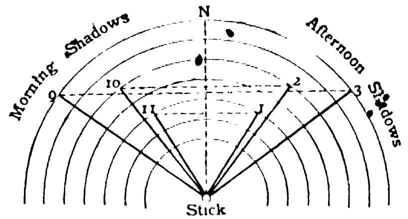


Fig. 50

Setting out a True North and South Line.—(i) *By Compass Needle.*—Allow the needle to swing round and ultimately come to rest, then, knowing the magnetic declination from recorded statistics, set out in chalk on the school playground your north and south line.

(ii) *By Shadows.*—Set up a stick at O, fig. 50, and allow rays of sun to fall on it. At the extremity of the shadow describe a circle and mark, say, nine o'clock. Repeat as in the diagram for ten o'clock, and so on. After noon repeat at one, two, three o'clock, &c. Observe how the shadow shortens till noon and then how it again lengthens. In each case we have two corresponding times, morning and afternoon, on the same circle. Join these two points, say 10 and 2, by a chord. Bisect and draw a perpendicular to the foot of the stick. Repeat for other points and we get a true north and south line.

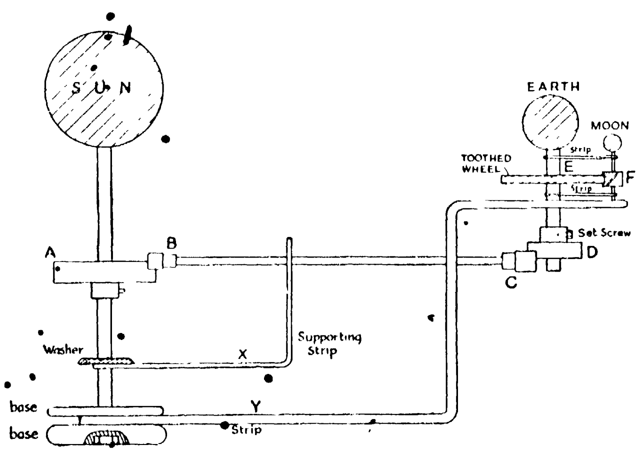


Fig. 51

(iii) *Boy Scouts' Method.*—If we had a clock face with twenty-four hours marked thereon, and pointed the hour hand to follow the course of the sun, then it would be easy to find the southern point, for at twelve noon, if we turned our watch so that the hour hand pointed

to the sun, it would also give us a north and south line. But in a watch the hour hand goes round twice in twenty-four hours, that is, goes 720°. Hence it travels at twice the speed at which the sun goes, or it goes twice as quickly as the hour hand of the clock above. However, if we turn the watch so that at, say, eight o'clock in the morning the hour hand points in the direction of the sun, then by bisecting the angle between this direction and the figure XII on the watch we get the position of the sun in the heavens at twelve noon, thus giving us a true north and south line.

A Home-made Tellurion.—The model shown in fig. 51 can be made for a few shillings from Meccano wheels and pinions, with the help of a few other odds and ends. The boys in fitting up learn more in this way than they would from heaps of lessons in mechanics on gear-wheels, &c.

A and D are crown wheels, costing about 1*s.* each in brass. B and C are pinions. The crown wheels are secured by set screws.

The whole is secured by stays. X and Y are secured as shown. The upright carrying the sun is secured by nut and bolt to a base board. The supporting strip is bored and moves round this upright between the two base boards, and hence has no vertical motion.

E is a toothed wheel, keyed or soldered to the upright carrying the earth, and engages a small pinion whose axis supports the moon. This axis is also supported.

It is impossible so to get the number of teeth on the wheels as to represent correctly the relative motions, but in trying to work out the results and so finding the defects in such a small model, boys learn a good deal of mechanics. It is a nice model, combining wood and elementary metal work.

The supporting strips are drilled with holes just sufficiently large to allow the axes to rotate through them without sticking.

Why Tides are Twenty Minutes Late.—Take a large rectangle of cardboard X Y Z O and cut out a hole for the large disc shown in diagram (fig. 52). Fit into this a tennis

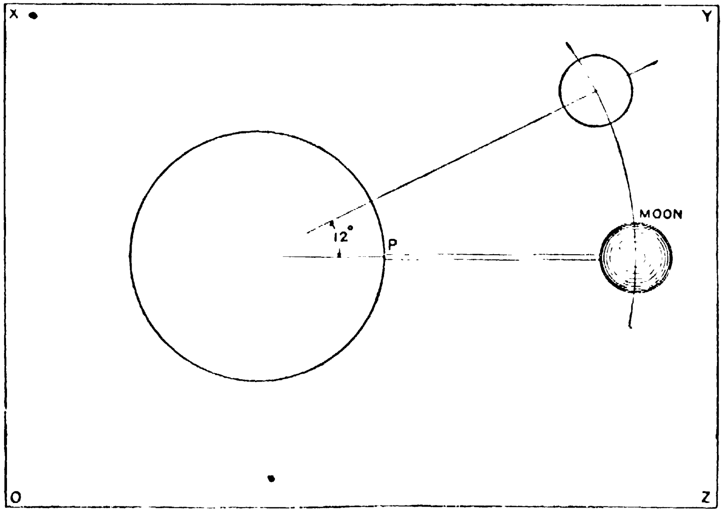


Fig. 52

ball. Fit similarly two smaller spheres to represent the moon in two positions as shown.

The earth moves round through 360° in twenty-four hours, but the moon goes through 360°, or round the earth, in thirty days, say. Hence the moon goes in one day through

$$360 \div 30 = 12°$$

Now, on looking at the diagram, boys will see that if we take high tide at P, after *one* complete rotation of the earth on its axis the point P will not now be in a direct line with the moon, on account of the latter's orbital motion—12° daily as indicated above. Hence the earth has to go on through other 12° before the next high tide occurs at P, which takes it—

$$\frac{12}{360} \text{ of } 24 \text{ hours}$$

$$\text{i.e. } \frac{1}{30} \text{ of } \frac{24 \times 60}{1}$$

i.e. 48 minutes approximately.

Boys will see from this model also that if high tide occurs at 12 noon, low tide will occur at 6.12; high tide at 12.24; low tide at 6.36; and high tide at 12.48 approximately.

This model, again, calls for ingenuity in cutting and sticking, and serves a useful purpose in geography. Decorations can be added according to individual's taste.

To Find the Altitude at any Place, having given the Latitude and Declination.—In the diagram (fig. 53), which is similar to the one used in finding the altitude of the pole star, we have first a large rectangular piece of cardboard, X Y Z O. Pinned to this is a circular disc M to represent the sun, and a short thin strip of paper connecting the sun to the larger disc of cardboard. This larger disc is graduated in degrees from 0°–360°. Then we have a piece of the shape shown A B C D, and movable about the centre on a loose pin. Let the boys find a number of towns on the same latitude, and also the declination north or south from *Whitaker's Almanac*, and then proceed as follows:—

Turn A to point to the latitude selected. Suppose 55° north, then if it should be the time of the equinoxes the angle between O and point C gives the altitude. If not, we must further move the disc A B C so as either to add or subtract the declination, depending upon

the fact of the sun being north or south of the equator. Vice versa, given the altitude we can find those places of the same latitude which have this altitude for the day in question.

This model calls for a lot of care in cutting and mounting, and is of great practical utility; and if used frequently, one of the knottiest points in physical geography is impressed far more securely than by heaps of words and diagrams on the blackboard.

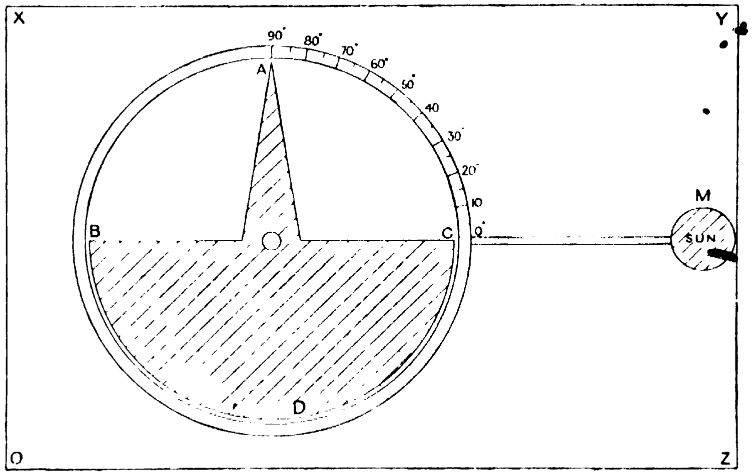


Fig. 53

As a variation, instead of having the sun and the strip fixed, we could have the sun represented by a ping-pong ball and movable in a concentric circle, so that when we point A to the latitude, instead of further moving it, we can move the sun either north or south to give it the required declination, and thus read off the altitude above point C.